Navigating the Dynamics of Digital B2B Platform Ecosystem Emergence and Orchestration

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"He was everything to my generation.
The lesson of hard work and, as cliché as it may sound,
the Mamba Mentality, that's part of the reason I am who I am today.
He was everything to a lot of kids, and I was one of them."
(Spencer Dinwiddie on the death of Kobe Bryant)

Abstract

Technological advancements and pervasive digitalization have reshaped fundamental paradigms of business. This gave rise to a new dominant organizational form, that of the digital platform ecosystem, which facilitates interaction, transaction, and information exchange in an unprecedented way. Given that a growing number of (emergent and incumbent) firms are embracing business models aligning with the concept of a digital platform ecosystem, this dissertation investigates the dynamics that underlie the emergence and orchestration of such organizational forms in the business-to-business (B2B) context. I build on prior work on digital platforms, business and innovation ecosystems, and different perspectives on their evolution, which developed in large parts in the business-to-consumer (B2C) context, to further the theoretical understanding of B2B platforms and develop strategic guidance for platform architects and orchestrators.

Doing so, this dissertation follows three research goals. The first research goal seeks to explore the socio-technical factors determining B2B platform adoption. Here, I identify and summarize technical, organizational, and environmental challenges impeding the adoption of the B2B platform (Essay 1). In addition, I investigate architectural features as the determining factor in offering distinct value propositions (Essay 2). These insights allow platform architects to address current challenges and better define platform value propositions to facilitate successful adoption. As the B2B environment poses different obstacles to platform development and market entry, the second research goal seeks to advance the portfolio of strategies platform architects can use to overcome such challenges and successfully guide a B2B platform to market entry. I develop such knowledge and present it in an actionable framework to be utilized by platform architects in different industries (Essay 3). The third research goal aims to provide guidance in orchestrating digital B2B platform ecosystems for sustainable and long-term evolution. Here, I develop a conceptual framework of platform orchestration (Essay 4) and analyze the effects of standardization as one instrument of platform orchestration in the B2B context (Essay 5).

In summary, this dissertation provides theoretical and practical insights into the emergence and orchestration of digital B2B platforms. Following a multi-method research approach, the dissertation's five essays allow for generating descriptive, analytical, and prescriptive knowledge that benefits the overall body of knowledge on digital platforms

and ecosystems, particularly the emergent literature stream on digital B2B platforms.

Keywords: *Digital Platform, Platform Ecosystem, B2B, Value Co-Creation, Platform Emergence, Platform Orchestration*

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Bayreuth, December 2023 *Laurin Arnold*

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Introduction to *Navigating the Dynamics of Digital B2B Platform Ecosystem Emergence and Orchestration*

Abstract

This dissertation studies the dynamics of the emergence and orchestration of digital B2B platform ecosystems. It comprises five essays structured along three overarching research goals that answer dedicated research questions of interest to platform architects and orchestrators. Following a multi-method research approach, the dissertation thereby offers descriptive, analytical, and prescriptive knowledge to enrich the academic discourse on digital platform ecosystems in general and digital B2B platform ecosystems in specific. In the following introduction to the dissertation, I first provide a general motivation for the overall research aim. Further, I review and summarize relevant literature on digital platforms and ecosystems to introduce important theoretical concepts and contextualize the dissertation within ongoing academic debates. In addition, I offer an explicit derivation of the three research goals that structure the five essays, present the methodology underlying each essay, and summarize their key findings. Finally, I discuss this dissertation's contribution to research, its implication for practice, limitations, and potentially fruitful avenues for future research on the emergence and orchestration of digital B2B platform ecosystems.

Keywords: *Digital B2B Platform, Platform Ecosystem, Emergence, Orchestration*

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1 Motivation

In the last two decades, we have witnessed the rise of digital platform ecosystems as the dominant method for organizing various economic and societal interactions, including value exchanging transactions, innovation, development, production, or consumption (Gawer, 2022; Parker, van Alstyne, & Choudary, 2017; Reuver et al., 2018). Instead of adhering to a conventional linear "value chain" model (e.g., Porter (1985)) or concentrating on internal production capabilities (e.g., Chandler (1962)), digital platforms position themselves as central hubs that create value by facilitating and coordinating interactions among diverse user groups (often referred to as the ecosystem surrounding the digital platform) and leverage network effects for never seen before growth (Cennamo, 2021; Gawer, 2014; Jacobides et al., 2018). The huge valuations and market success of major corporations that follow a digital platform strategy, such as Amazon, Microsoft, Alphabet, or Apple, underscore the potential of this new form of organizing. Further, the ongoing wave of digitalization fostering, for instance, digital servitization, process automation, and big data utilization is propelling the expansion of platform-based approaches throughout many industries (Cenamor et al., 2017; Ozalp et al., 2022; Svahn et al., 2017). Consequently, a growing number of emergent firms are embracing a *born open* concept, aligning with multi-sided platform business models. Simultaneously, numerous incumbent industry leaders traditionally characterized as *born closed* are actively exploring the integration of platform principles into their business models (Boudreau, 2017; Grover & Kohli, 2012; P. Huang et al., 2018).

Digital platforms leverage the contributions of external and independent partners to offer a particularly comprehensive and complex value proposition to their customers (Cennamo, 2021; Gawer, 2014; Hein et al., 2020). This allows them to be highly innovative and grow extremely fast, all while maintaining a small asset base (Chesbrough, 2003; Gawer, 2022). However, digital platforms perceptibly alter the way how firms operate today. While in the past, the mastery of value chain activities decided on a firm's success, for digital platforms, the ability to attract partners complementing the platform's focal value offer is the key criterion for success (McIntyre & Srinivasan, 2017; Stummer et al., 2018). This proves challenging, as many platforms fail to achieve the critical mass necessary for network effects to kick in. Hence, how digital platforms emerge and how operators must orchestrate them to be successful unfolded as an important research topic (Daymond et al., 2023; D. S. Evans & Schmalensee, 2010).

This knowledge is not only relevant in end-consumer and software markets, as one might presume given the examples above. Many traditional, business-to-business (B2B) oriented, and asset-heavy industries have realized that operating vertically integrated may not be the best approach to solve customer problems anymore. Indeed, given the rapid digitalization in many industries, many firms do not have the capacities to adapt to all emerging customer demands on their own (Kolagar et al., 2022; Sjödin et al., 2022). Hence, they are on the verge of transforming to use the potential of digital platform ecosystems to expand their internal offerings with complementary products and services from third parties (Holgersson et al., 2022). For instance, many industrial firms have begun to embrace so-called digital servitization to extend the value proposition of products with innovative capabilities (Cenamor et al., 2017; Föhr & Germelmann, 2022; Jovanovic et al., 2022; Paiola & Gebauer, 2020). This can be achieved by connecting the current bases of (industrial) products to a core technological system (i.e., a digital platform) that lets others provide digital solutions to make use of customer data and, thus, create and capture greater value (Kiel et al., 2017). Integrating complementary actors can thus help to bring in innovative offerings to a firm's product portfolio and provide novel and extended opportunities for value creation and capture (Hein, Weking, et al., 2019; Madanaguli et al., 2023).

However, the lion's share of management and information systems literature on digital platforms has focused on business-to-consumer (B2C) and less so on B2B platforms (Anderson et al., 2022; Madanaguli et al., 2023). Consequently, our understanding of digital platforms commonly relates to platforms serving markets with end-consumers as at least one of their participant groups. The implicit assumption in much of this work is that findings generalize and apply just as well to B2B markets. However, when digital platforms connect businesses to other businesses, platform architects and orchestrators face an altogether different set of challenges when developing and operating B2B platforms that are not exhaustively captured by the literature. As a result, significant research gaps exist to explain how B2B platforms can successfully emerge and evolve into a dominant market position. These blind spots are also emphasized by recent review papers investigating the intersection of digital platforms and B2B markets (Madanaguli et al., 2023; Reuver et al., 2018; Shree et al., 2021).

Therefore, a better understanding of how digital B2B platform ecosystems emerge and operate is of great concern for everyone interested in the successful implementation of

the concept in the B2B context. In this thesis, I aim to contribute to such understanding through specific findings that inform platform architects and orchestrators. In line with other literature, I refer to a platform architect as the person who initiates, designs, and develops a digital platform to bring it into existence (Daymond et al., 2023; Snihur et al., 2018). In addition, I refer to a platform orchestrator as the operator of a digital platform ecosystem that coordinates value creation and capture to ensure its long-term successful evolution (Autio, 2022; Dhanaraj & Parkhe, 2006; Thomas & Ritala, 2022). While the roles are often covered by the same person(s)[1], I divide them to demarcate the distinct activities and challenges that platform emergence and orchestration entail.

Motivated by the limited understanding outlined above, this dissertation's overarching research objective is to contribute to a better understanding of how digital B2B platform ecosystems can successfully emerge and how they must be orchestrated for sustainable evolution. I address this research objective through five studies. Each study investigates a specific aspect that informs a better understanding of B2B platform emergence and orchestration. Thus, this dissertation contributes to current discourses on digital platform ecosystems in general and B2B platform ecosystems in specific.

The introduction of this dissertation proceeds as follows: In Section 2, I review relevant literature on digital platforms and ecosystems. Doing so, I introduce important theoretical concepts and arguments and contextualize this work in ongoing debates about digital platform ecosystems in general. In Section 3, I derive research gaps and questions along three research goals that inquire about the emergence and orchestration of digital B2B platform ecosystems and that form the structure of this dissertation. In Section 4, I provide an overview of the research paradigm underlying my research and the research design and methods of each study. In Section 5, I summarize the main results of the five studies. Last, in Section 6, I discuss the results by highlighting the studies' contribution and implications for theory and practice, outlining their boundary conditions, and pointing towards future research opportunities.

The introduction to this thesis partly comprises content from the research articles. I have omitted the standard labeling of these citations so as to improve readability.

[1] The literature uses various terms, such as platform provider (e.g., Cennamo and Santalo (2013)), sponsor (e.g., Rietveld et al. (2019)), operator (e.g., Hukal et al. (2022)), or market maker (e.g., Grewal et al. 2010) to describe this overall role. Regardless of the name, its purpose is always to differ between the entity that owns the platform and executes control and other parties using the platform.

2 Conceptual Background

This section reviews and summarizes the literature on digital platforms and ecosystems. Its objective is twofold: first, it contextualizes the dissertation within ongoing debates about digital platforms and ecosystems by summarizing the latest arguments and topics in the broader management and information systems research field. Second, it introduces important theoretical concepts and ideas that underpin the research undertaken in this dissertation, setting the stage for the ensuing empirical essays.

2.1 Digitalization and its Economic Impact on the Emergence of Digital Platform Ecosystems

The pervasive transformation of analog information into digital data and the increasing use of digital technologies in society and industries – often described as digitization or digitalization (e.g., Tilson et al. (2010)) and digital transformation (e.g., Vial (2019)) – have strongly reshaped the organizational landscape for firms in various industries (Urbach & Ahlemann, 2019; L. Wessel et al., 2021; Y. Yoo et al., 2010). Among the most significant consequences of this transformation is the rise of digital platforms with a surrounding ecosystem of autonomous actors as the dominant form of organizing firms in the digital age (Bharadwaj et al., 2013; Gawer, 2022; Parker & van Alstyne, 2005). The synergy between the digital transformation and the emergence of digital platform ecosystems has engendered a paradigm shift in how firms collaborate to create and capture value today. I will briefly outline some of the most important drivers of this in the following[2].

Digitalization and the widespread presence of information and communication technologies have given rise to a global techno-social environment of pervasive connectivity, generating vast amounts of data in different areas (e.g., user behavior, machine processes, market transactions) (Gawer, 2022; Y. Yoo et al., 2012). This prevalence has shifted the focus of value creation, delivery, and capture, as technology has made it possible to offer new digital products and services based on the analysis and use of these data (Autio et al., 2018; Lyytinen, 2022). Often, these data-driven insights enable business models that build on novel transaction designs to individually connect specific user groups (e.g., supply and demand) for value exchange (McIntyre & Srinivasan,

[2] More detailed analysis can be found in Gawer (2022), Jacobides et al. (2024), or Teece (2018).

2017; Reuver et al., 2018). In these settings, digital platforms contribute to economic efficiency through precise resource allocation and reduce transaction costs through automation and cost-efficient processes (Cusumano et al., 2019; Rochet & Tirole, 2006).

Further, digital products[3] that consume data (and often generate new data itself) rely on a modular architecture (Baldwin & Woodard, 2009; Ulrich, 1995) and a re-programmable functionality (Y. Yoo et al., 2010), inducing less asset specificity which enables fungibility in different markets (Gawer, 2022). These characteristics have led to the formation of innovation ecosystems that leverage combinations of complementary[4] functionalities of different digital products to offer unique value (Borner et al., 2023; Jacobides et al., 2018; Sandberg et al., 2020). Successfully organizing such innovation ecosystems requires the integration of third parties, which impacts the boundary of a firm and the structure of the value chain (Ghazawneh & Henfridsson, 2013; Gilette, 2011; Parker & van Alstyne, 2018). Parker, van Alstyne, and Jiang (2017) describe the situation resulting from the decision to innovate using external partners in preference to (previously followed) closed vertical integration as the inversion of the firm. That is, the locus of value creation moves from inside the firm to outside. Digital platforms are prone to such organizing and allow firms to harness complementary external innovation in addition to their own internal innovations (Chesbrough, 2003; Parker & van Alstyne, 2018).

This inversion of the firm also fundamentally changes economic and competitive mechanisms (Cennamo, 2021). While firms following a linear value chain model have successfully leveraged supply-side economies of scale for the past century, the digital economy, which rests on data-driven insights, matching of supply and demand, complementarities, and third-party innovation, leverages demand-side economies of scale, also known as network effects (Gawer, 2014; Katz & Shapiro, 1985). Network effects arise when the value a participant derives from joining a platform is an increasing function of the number of other participants on the same platform (Katz & Shapiro, 1985; McIntyre & Srinivasan, 2017). That is, participants are incentivized to join a single platform rather than spreading across many competing ones as platform firms that achieve higher volume (e.g., of data, participants, or software-based innovation) can offer

3 For a conceptualization of "digital products" see, for example, Kallinikos et al. (2013).

4 Following Brandenburger and Nalebuff (1996), a complement to one product or service is any other product or service that makes the first one more attractive.

higher value to customers because they can better match supply and demand or offer greater consumption benefits for customers through ever-expanding consumption options (Cennamo, 2021; Gregory et al., 2021, 2022).

In summary, digitalization and digital transformation led to a global restructuring of value creation, delivery, and capture processes, enabling digital platforms to emerge as the dominant organizational form (Autio et al., 2018; Gawer, 2022). I will continue by describing the concept of a digital platform ecosystem in more detail.

2.2 Digital Platform Ecosystems from an IS Perspective

Digital platforms and *ecosystems* exhibit significant overlap and interdependence, even though scholarly discussions have primarily evolved separately. The extent to which these constructs are interrelated hinges on the precise definitions employed in each context: the more stringent the definitions, the more distinct the boundaries become. Notably, a platform typically encompasses elements of an ecosystem, while conversely, an ecosystem frequently relies on a digital platform as its foundation. To elucidate this relationship, I first shift to the distinct emphases of these concepts separately before bringing them together and discussing the literature at the intersection of digital platform ecosystems and their evolution.

2.2.1 Typologies of Digital Platforms

In information systems and management literature, digital platforms are commonly linked with the notion of an infrastructure that provides a technological underpinning utilized either internally within organizations or across them (Constantinides et al., 2018; Tiwana et al., 2010). This serves the goal of enabling transactions or fostering engagement and facilitating innovation. Thus, Jacobides et al. (2024) refer to digital platforms as “inter-organizational value architectures based on technological architectures and economic market structures” (p.3). Enabling technologically mediated interaction between user groups, digital platforms allow those user groups to carry out defined tasks (Bonina et al., 2021; Cusumano et al., 2019).

Mirroring these tasks, the literature on digital platforms has developed in different streams and has taken different perspectives. While interrelated and partially overlapping, these streams have distinct views on platforms, and researchers follow different interests regarding platform phenomena. Hence, if one seeks to understand particular phenomena in the digital platform context, it makes sense to deconstruct the abstract definition of digital platforms into distinct meta-typologies (see Table 1).

Table 1. Overview of Platform Typologies (adapted from Bonina et al. (2021) and Cennamo (2021))

	Digital platforms as multi-sided marketplaces	**Digital platforms as modular technology systems**	**Digital platforms as information-channeling infrastructures**
Purpose	Digital platforms are multi-sided market infrastructures that connect otherwise unconnected user groups and facilitate value exchange transactions among them.	Digital platforms are modular technology systems that provide a core technological architecture that can be extended with complementary products or services by third parties.	Digital platforms are information-channeling infrastructures that categorize and store specific – and often user-generated – content and enable user interaction through matching and exchanging this content.
Informing literature stream	Driven by economics of information systems.	Driven by the software engineering perspective on modular architectures.	Driven by the socio-technical perspective of information systems
Basis of value creation	Reducing transaction costs of value exchange interactions: Matchmaking: The value of platforms grows as the user base expands, consequently enhancing the probability of achieving a more favorable match. Reducing frictions: Platforms make interactions frictionless and as easy as possible.	Facilitating the innovation of new products and services by third parties: Opening: Opening the core technology for third parties to innovate with. Resourcing: Providing developers with the resources and knowledge they need to innovate.	Organizing user-generated content and facilitating interaction of users to exchange content: Matchmaking: Matching users based on information they care about most Reducing frictions: Facilitating exchange and sharing of information with others.
Source of value capture	Charging for platform access or imposing a commission on transactions facilitated by the platform.	Charging for access to the platform through licensing arrangements or charging commission on sales of complementary services.	Analyzing the data captured from users and their behavior and sourcing it for targeted advertisement.
Examples	Amazon Marketplace, eBay, Uber, Airbnb, Groupon	Apple iOS, Google Android, SAP NetWeaver, Shopify	LinkedIn, Twitter/X, TripAdvisor, YouTube, Reddit

Digital platforms as multi-sided marketplaces

First, digital platforms are seen as multi-sided marketplaces that connect actors (e.g., providers of goods and services with customers) that would have been hard to connect otherwise and facilitate value exchange transactions among them (Cennamo, 2021; Gawer, 2014). Initial work building the foundation for this stream stems from economic literature and discusses competition and product compatibility in the presence of network externalities[5] (Farrell & Saloner, 1985; Katz & Shapiro, 1985). With the rise of the internet at the cusp of the new millennium, this stream surged as connecting seemingly dispersed groups became easier and infrastructures enabling their interaction could benefit from network effects[6] (e.g., Amit and Zott (2001), Caillaud and Jullien (2003), Rochet and Tirole (2003), Armstrong (2006)).

Network effects that arise between two or multiple sides of a market are at the center of this perspective of digital platforms. Two kinds of network effects can be distinguished in this regard: direct network effects occur when the value of a product or service increases as more users join the same network[7]. Indirect network effects occur when the value of a product or service for one user group depends on the number of users of another group[8]. Hence, indirect network effects emulate a pre-existing interdependence and complementarity in demand of two or multiple distinct user groups (Gawer, 2014). As a result, network effects are the main driver of competition between platforms, as they ignite a positive feedback loop that can result in a "winner-takes-all" outcome (Eisenmann, 2006). Most studies of this stream are thus interested in how to overcome the colloquial 'chicken-and-egg problem' of network markets and initially and continuously attract multiple sides to the platform (e.g., Ochs and Park (2010), Hagiu and Spulber (2013), Boudreau (2021), Garud et al. (2022)).

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5 In economic terms, externalities refer to the consequences (positive or negative) of an activity that affect others and that are not accounted for by its producer (Jacobides et al., 2024).

6 D. S. Evans (2003) outlines that multi-sided platform markets increase social surplus when three conditions are met: first, there are distinct user groups; second, members of one group benefit from having their demand coordinated with one or more members of another group; third, an intermediary can facilitate that coordination more efficiently than bilateral relationships between the members.

7 For example, riders on Uber benefit from more riders when looking to carpool. Similarly, users of social networks benefit from more users to build connections with.

8 For example, riders on Uber benefit from drivers offering ride services. Similarly, sellers on Amazon benefit from the presence of more buyers to offer their products and services to.

As value architectures, multi-sided transaction platforms offer opportunities for new value creation. This is based on transforming inputs from one user group into outputs for another, with the latter incorporating a value-add compared to the input (Brandenburger & Stuart, 1996). Successful transaction platforms must not only create a value-add but also appropriate a share of it (Hein et al., 2020). Multi-sided transaction platforms create value by reducing transaction costs for all users, which take the form of more efficient matchmaking and less friction in the resulting interaction (Bonina et al., 2021). They capture value through various pricing mechanisms such as charges for access, memberships, or per use/transaction (Cabral, 2019; Roger & Vasconcelos, 2014; Zimmermann et al., 2018).

Digital platforms as modular technology systems

Second, digital platforms are seen as modular technology systems that enable third parties (so-called complementors) to co-innovate products and services as complementary sub-systems to a core technology system and thereby provide additional value to the users of that system. This stream builds on the research of modularity of technology (Schilling, 2000; Ulrich, 1995), decomposition of systems to mitigate the effects of complexity (Baldwin & Woodard, 2009; Simon, 1962), and standardization of interfaces enabling interaction (Tilson et al., 2010; Y. Yoo et al., 2010). In a foundational paper for this stream, Tiwana et al. (2010) defined technology platforms as "the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate" (p. 675). Hence, modular technology platforms provide a new organizational form to incorporate the innovation capabilities of third parties to achieve complementarity in products and services and offer an integrated solution tailored to the needs of a customer (Cennamo, 2021; Gawer, 2014; Thomas et al., 2014). This is enabled by dividing responsibilities and labor along the innovation value chain, which leads to the specialization of a firm's tasks: the platform firm creates and provides the infrastructure as well as a set of functionalities and resources to serve as the basis for innovation and integration of new complements with this infrastructure. Third parties specialize in the development of complementary products and services, which they find to enhance the platform's functionality and attractiveness (Cennamo, 2021). As a result, most studies in this stream either focus on the platform architecture and its consequences for innovation (Eaton et al., 2015; Foerderer et al., 2019; Wulf & Blohm, 2020) or the intricate

dynamics arising between the platform and its complementors, as the platform firm needs to balance desirable and undesirable innovation for successful platform growth (Boudreau, 2012; Hukal et al., 2020; Rietveld et al., 2019; Wareham et al., 2014).

Modular technology platforms create value by enabling the co-innovation of complementary products and services for a core technology platform, which can be offered as an integrated solution to customers. This is possible through opening up the technology and letting third parties reuse single components for innovation as well as resourcing these third parties with the necessary capabilities to do so (Bonina et al., 2021). Value appropriation most often involves monetizing access or use of platform resources by complementors or capturing a share of the sales or rents of complements to customers.

Digital platforms as information-channeling infrastructures

Third, digital platforms are seen as information-channeling infrastructures that categorize and store specific – and often user-generated – content and enable interaction of users through matching and exchange of this content (Cennamo, 2021). Therefore, platforms offer specific tools (also called "filter", e.g., Parker, van Alstyne, and Choudary (2017)) to group information according to user's preferences or search, enable sharing of content with other users internal or external of the platform to engage interactions, and match users according to their likings or will (Faraj et al., 2011; P. Huang et al., 2018). As the primary good exchanged on these platforms is information, their quality is of utmost importance for the value creation of the platform (Cennamo, 2021; Khern-am-nuai et al., 2018). Further, while multi-sided transaction platforms and modular technology platforms largely rely on indirect network effects to propel growth, information platforms build on social or community dynamics that often rely on direct network effects. As a result of these characteristics, the literature in this stream is interested in engaging and managing interactions of users, incentivizing qualitative content generation on the platform that attracts others and enables new interactions, or controlling unwanted user behavior (Dissanayake et al., 2019; P. Huang et al., 2018; Khern-am-nuai et al., 2018; Kuang et al., 2019; H. Ye & Kankanhalli, 2017).

Information platforms create value through matching and connecting users and enabling the exchange of information among them. As the exchange of information does not include a monetary transaction, information platforms often capture value through

the monetization of indirect services, such as advertisements of third parties targeting specific user groups (Cennamo, 2021; Seamans & Zhu, 2014).

While the three meta-typologies are presented here as rather distinct, the reality shows that digital platforms often combine different elements to different degrees. For example, modular technology platforms such as Android often incorporate marketplace characteristics (i.e., the Play Store) to facilitate easy diffusion of innovative products and services and provide incentives for complementors through direct access to the core technology's users. In addition, Android also builds on information platform characteristics to help its third-party community to exchange ideas on development problems or comment on new features. Scholars, therefore, refer to many digital platforms as hybrids of these typologies (Bonina et al., 2021; Cusumano et al., 2019). However, for theoretically thinking about platform phenomena, breaking down digital platforms into their logical components proves helpful as it enables analyzing unique characteristics of different instantiations.

Last, one more point is worth mentioning: the *platform* term is also related to other concepts that need to be separated from the view of a digital platform as outlined above. On the one hand, digital platforms are separate from physical product platforms, such as car bodies that enable automotive manufacturers to build different car variants (Gawer, 2014; Thomas et al., 2014) and non-digital network markets (also often called a platform by economists) such as credit card systems. Second, digital platforms are distinct from regular IT artifacts and infrastructures such as technology standards (e.g., USB) or data centers (Constantinides et al., 2018; Cusumano, 2010). While they share some characteristics, digital platforms lend particular affordances for value creating interactions between different users. For the remainder of this thesis, I will refer to a digital platform as primarily a modular technology system.

2.2.2 Merging Digital Platforms and Ecosystems

In parallel to studies focusing on either type of digital platform, the concept of *ecosystem* has developed rather separately in the literature. The term originally stems from ecology, where it denotes "the physical and biological components of an environment considered in relation to each other as a unit" (Willis, 1997, p. 268). In other words, it describes the sum of all living organisms (e.g., plants or animals) and physical components (e.g., water, soil, light) and their interaction with each other (Mens et al., 2014).

Lending the ecosystem metaphor for business contexts provides heuristics to guide practice as well as models for academia to theorize on the complexity of purposeful, interconnected, and heterogeneous systems (Daymond et al., 2023). Hence, management scholars adopted the term to describe a "business ecosystem" as a community of economic actors that align and cooperatively and competitively interact for a focal value proposition to materialize (e.g., Moore (1993), Iansiti and Levien (2004), Adner (2017), R. Kapoor (2018), Jacobides et al. (2018)) or an "innovation ecosystem" as a combination of actors that contribute key parts to making an innovation come to life (e.g., Adner (2006), Adner and Kapoor (2010), West and Wood (2017), Thomas and Autio (2020)). The ecosystem metaphor has been useful in these institutional settings, as it enabled a new way of theorizing on strategy to manage complex, purposeful, interconnected, and heterogeneous systems (Daymond et al., 2023). In sum, these concepts align in their view to jointly create value in a way that no single actor would be able to do (Adner, 2006; Bogers et al., 2019; Williamson & Meyer, 2012).

Besides management, the software engineering domain adopted the term to reflect on the increasing complexity and scale of software systems and their collaborative development within a community of developers (Manikas & Hansen, 2013; Messerschmitt & Szyperski, 2019). Scholars here refer to a "software ecosystem" as a collection of software development projects that evolve together in the same environment, resulting in a number of different solutions and services (Jansen et al., 2009; Lungu, 2008; Manikas & Hansen, 2013). Typically, these software projects compete as they cater to the same users or provide similar functionalities.

Influenced by the vocabulary of management and software engineering, the information systems field also developed great interest in the metaphor to describe phenomena of co-innovation of features. The concept of a platform ecosystem was first introduced by Gawer and Cusumano (2002), which elaborated on how technology firms such as Microsoft, Intel, and Cisco drove innovation around a core platform technology. Compared to business or innovation ecosystems, however, platform ecosystems do not focus on the alignment of interests of different actors to enable a focal value proposition. Instead, they rely on autonomous actors contributing complements at their will, with the sufficient condition that "the complementarities among products and/or actions must be strong enough to require coordination but not so strong as to need unified governance" (Baldwin, 2021, p. 6). Hence, platform ecosystems can be

interpreted as a mélange of business, innovation, and software ecosystems, with an underlying digital platform as the foundational infrastructure. Research refers to these organizational forms also as meta-organizations (Blackburn et al., 2023; Chen, Tong, et al., 2022; Kretschmer et al., 2022).

The ambiguity of related terms[9] illustrates the lack of a single integrated concept for digital platform ecosystems. The *digital platform* part caters to the technological system that provides the infrastructure, whereas the *ecosystem* part describes the inter-organizational arrangement that allows different actors (i.e., individuals or firms) to collaborate and jointly create value and customers to consume it (Jacobides et al., 2024). Thus, although many ecosystems are built upon digital platforms, the presence of one is not a prerequisite for the formation and functioning of an ecosystem. That said, digital platforms are often linked with ecosystems, which is why I will refer - in line with most studies in the literature - to a digital platform ecosystem[10].

2.2.3 Emergence of Digital Platform Ecosystems

The promise of economic and social benefits associated with digital platform ecosystems makes their emergence for new purposes of interest for practice and theory alike (Kretschmer et al., 2022; Ritala, 2023). Emergence can be viewed as the "process that involves (1) the creation of novelty, (2) its growth to a salient size, and (3) its formation into a recognizable social object" (Seidel & Greve, 2017, p. 2). This process is partly reflected in studies on the evolution of digital platform ecosystems (Kyprianou, 2018; Shi et al., 2021; Tan et al., 2015). Scholars study platform evolution by investigating it as a gradual process of several phases[11]. Multiple derivatives of evolution perspectives can be found, focusing on growth, transformation, or maturity aspects (Staykova & Damsgaard, 2017). Maturity models, for instance, suggest that platform ecosystems pass through different life-cycle periods such as birth, launch, expansion, leadership, and, ultimately, reinvention or death (e.g., Moore (1993), Parker, van Alstyne, and

[9] See for example alternate terms used in the literature such as software-based platform (e.g., Tiwana et al. (2010)), platform-mediated network (e.g., McIntyre and Srinivasan (2017)), platform-based market (e.g., Zhu and Iansiti (2012)), industry platform (e.g., Gawer (2014)) or internet platform (e.g., Bakos and Katsamakas (2008)).

[10] For simplicity reasons, I will use the abbreviated form *platform ecosystem* synonymously.

[11] Henfridsson and Bygstad (2013) refer to platform evolution as "the process through which a digital platform changes into a more complex form".

Choudary (2017), Teece (2017)). Following this stance, platform architects seek to understand how to nurture digital platforms from their initiation through market entry to established functioning (Daymond et al., 2023).

Literature on digital platform ecosystems has identified obstacles that need to be overcome as well as various enablers and facilitators contributing to the emergence of platform ecosystems. Most discussed is the challenge of overcoming the so-called "chicken-and-egg" problem (Armstrong, 2006; Caillaud & Jullien, 2003). It results from indirect network effects and describes the dilemma of platforms that, in order to attract users to one side of the market (e.g., sellers on eBay), an installed base of users (e.g., consumers) on the other side is required. However, one side will only join a platform if they expect a critical mass of users to be present already. Scholars describe various strategies to overcome this problem of early-stage platform development (Edelmann, 2015; Ochs & Park, 2010; Parker, van Alstyne, & Choudary, 2017; Stummer et al., 2018).

Most of these strategies involve discussions on how platform ecosystems achieve adoption with complementors and users[12]. In this context, early work focused mostly on pricing decisions as the key argument for platform membership or use (Armstrong, 2006; Eisenmann, 2006; Hagiu & Spulber, 2013). More recently, literature has also discussed non-pecuniary approaches, such as "seeding" initial content, services, or products by the platform operator itself to ensure sufficient supply and kickstart initial transactions (P. Huang et al., 2018), pursue exclusive or high value offerings (Agarwal et al., 2023; Carroni et al., 2023), or leverage self-fulfilling expectations by optimistically speaking about the platform's future growth (Boudreau, 2021; Ochs & Park, 2010). Further, scholars have identified and discussed characteristics such as technological difficulties and adaptation costs (Ozalp et al., 2018), governance structures (P. Huang et al., 2013; Thomas et al., 2014), a platform's innovativeness, and differentiation (Anderson et al., 2014; Cennamo & Santaló, 2019) as important factors impacting complementor's and user's adoption decision.

While platform architects can steer and capitalize on these aspects and strategies, a pool of more abstract enablers and facilitators also influences the emergence of platform ecosystems. These include, for instance, technological trajectories combining

[12] Some strategies such as "envelopment" (e.g., Eisenmann et al. (2011)) focus on acquiring the user base through different ways than adoption.

technology push and demand pull perspectives that may lead to digital convergence enabling new business models (Hein, Schreieck, et al., 2019), competitive pressures due to dominant firms or platforms undermining other firms' competitiveness (Khanagha et al., 2022), or the availability of (dynamic) capabilities for coordination, configuration, and technology development of a new platform ecosystem (Helfat & Raubitschek, 2018; Svahn et al., 2017; Tan et al., 2015). In addition, regulatory changes can also either enable or amplify the adoption process of new platform ecosystems (Hein, Schreieck, et al., 2019).

Addressing these characteristics to nurture the emergence of platform ecosystems as well as securing their successful operation and long-term evolution, requires thoughtful platform governance. I will present the fundamental elements of this concept next.

2.2.4 Governance of Digital Platform Ecosystems

Literature widely assumes that the platform owner performs the solitary role of orchestrating the constant running of a digital platform ecosystem (Chen, Yi, et al., 2022; Gawer & Cusumano, 2008). In line with classic strategy research (e.g., Barney (1991)) they do so by enforcing platform governance mechanisms and strategies to coordinate value co-creation and capture on the platform (Chen, Tong, et al., 2022; Karhu et al., 2020; Rietveld & Schilling, 2021). As value co-creation and capture processes on platforms raise different collective-action problems (e.g., Engert et al. (2023)), platform governance must, on the one hand, set the right incentives to enable interaction between participants or the platform, and on the other hand control activities and behavior of participants (Chen, Tong, et al., 2022; Zhang et al., 2022). Most critical to this is to find the delicate balance between enough control to avoid undesired variation of complementors or quality of offered products and services and enough openness to allow for innovation and new transaction designs (Boudreau, 2012; Wareham et al., 2014)[13]. As Faraj et al. (2011) describe, the goal is to create a situation of "constrained serendipity".

[13] With some conceptual variation, the literature refers to this trade-off also as "generativity vs. control" (Eaton et al., 2015), "flexibility vs. control" (Svahn et al., 2017), or "resourcing vs. securing" (Ghazawneh and Henfridsson 2013).

Given their digital nature and the fact that platforms offer an organizational system with less explicit authority over participants than in traditional hierarchical firms (Kretschmer et al., 2022), many platform governance mechanisms and strategies are enforced through digital design features of the platform core or its boundary (Eaton et al., 2015; Ghazawneh & Henfridsson, 2013; Wareham et al., 2014). Leveraging their power as the owner of these technological assets, platform owners can choose architectural designs such as standardized interfaces (e.g., Karhu et al. (2018)) or knowledge resources (e.g., Foerderer et al. (2019)) to enforce control or provide incentives and, thus, achieve desired orchestration outcomes (Boudreau, 2017; Kretschmer et al., 2022). Further, platform governance is also about defining a value appropriation scheme that fits the goals of not only the platform owner but also third parties complementing the platform (Parker, van Alstyne, & Choudary, 2017). To incentivize third parties to engage with the platform, platform owners offer a share of the co-created revenue as compensation. This, however, decreases their own share of the value they can appropriate from the platform, which creates a difficult trade-off to solve (Panico & Cennamo, 2022)[14]. Last, as platforms compete with other firms or platforms for overall market share as well as with complementors with the ecosystem for potential value capture, platform governance must define how to approach these competitive situations (Ghazawneh & Henfridsson, 2013; Rietveld & Schilling, 2021; Zhu, 2019).

2.3 Business-to-Business oriented Digital Platform Ecosystems

As the concept of a digital platform ecosystem and its general understanding has primarily emerged in markets with end-consumers on at least one side, its main theoretical reasoning best fits with this context (Rietveld & Schilling, 2021). However, instances of platforms that exclusively cater to interactions between businesses are increasingly important for economic activity worldwide, yet they differ in important aspects from thus far studied examples. This limits the transferability of knowledge from one context to the other. I will now narrow the focus and delve deeper into the specialized form of business-to-business (B2B) oriented digital platform ecosystems[15].

[14] The study of Panico and Cennamo (2020), for instance, illustrates that when complementors are provided with upfront investment incentives aimed at fostering value creation, such as a greater portion of the co-created value, it results in a reduction of the platform's ability to capture value thereafter, and vice versa.

[15] For simplicity reasons, I will refer to them as *B2B platforms*.

Therefore, the first section will clarify fundamental differences between B2C and B2B platform ecosystems that impact their emergence and orchestration. The second section will present emerging insights the academic literature on digital B2B platform ecosystems has thus far developed.

2.3.1 Differences between B2C and B2B Platform Ecosystems

B2B platforms follow a similar logic of already known platform ecosystem characteristics, such as the existence and varying strength of network effects (Boudreau et al., 2022; Li & Penard, 2014) mechanisms for value co-creation and capture (Hein, Weking, et al., 2019), or the generative nature of the digital platform and complementary assets (Pauli et al., 2021; Thomas & Tee, 2022). Hence, the typologies of digital platforms, as laid out earlier, also account for B2B platforms.

However, B2B platforms also differ from their B2C counterparts in several important ways, such as the organizational structure and defined operations of businesses as platform participants or the competition they encounter among each other. In a recent study, Anderson et al. (2022) summarize and structure the main distinctions along five dimensions: first, the landscape of B2B platform users is distinctly shaped by the complex and specialized nature of business operations, setting it apart from end-consumer oriented platforms. This can be described as “operational complexity” (ibid.). Businesses, while demanding higher levels of functionality, must also navigate a multitude of operational technologies to integrate with the platform and coordinate their activities within established and extensive supply chains (Pauli et al., 2021; Pauli et al., 2020; Schreieck et al., 2021). Functional requirements in the B2B often necessitate tailored solutions, as opposed to the one-size-fits-all approach common in B2C settings, rendering B2B platforms more selective in their engagement with third-party developers (Anderson et al., 2022; Hein, Weking, et al., 2019). Further, businesses as customers follow structured processes, such as procurement and software implementation, in contrast to the plug-and-play dynamics observed among end-consumers. The emphasis on specific expertise, which often requires the platform operator’s involvement in selected processes, amplifies the costs associated with onboarding users to B2B platforms, introducing greater friction in the process compared to their B2C counterparts. Consequently, B2B platforms tend to adopt an industry-specific approach rather than offering generic solutions (Anderson et al., 2022).

Moreover, the inherent complexity and industry-specific expectations within B2B platform ecosystems limit the pool of participants for cross-side transactions (Madanaguli et al., 2023; Ritala & Jovanovic, 2024). Once businesses connect on a B2B platform, they often exercise caution when interacting with competitors within the same ecosystem. As competitive entities targeting similar customer segments, they may opt to shield their pricing and sensitive information, contributing to intensified competition, reduced trust, and apprehensions about potential lock-in; all such are issues that B2B relationships typically aim to avoid. In this context, the careful selection of the platform, as well as the owner's role as a user on the platform, can significantly impact a business's access and relationships with its customers through the platform (Anderson et al., 2022; Schreieck, Clemons, et al., 2019).

Lastly, businesses exhibit a heightened sensitivity toward data security and privacy compared to consumers. This translates into a reluctance to share data, and when they do, it often comes with conditions or compensation requirements. Collectively, the presence of competition and data-sharing reservations place constraints on the ability of B2B platforms to deliver same-side value. Initial research findings in the B2B platform literature suggest a reduced emphasis on network effects, owing to the platforms' industry-specific nature, and a departure from the traditional "winner-takes-all" logic observed in B2C platforms, where transactions are more generic and complementors are more interchangeable (McIntyre, 2019; Pauli et al., 2021).

In summary, B2B platforms operate in specific industries that require solving complex coordination problems at a high level of technical sophistication just to address a limited yet heterogeneous market of potential customers. This requires adapting many thus far developed platform strategies to fit this new context. Table 2 summarizes the differences between B2B and B2C platform ecosystems along the five dimensions proposed by Anderson et al. (2022).

Table 2. Summary of Differences between B2B and B2C Platform Ecosystems (adapted from Anderson et al. (2022))

Dimension	Business-to-Business Platform Ecosystem	Business-to-Consumer Platform Ecosystems
Operational Complexity	Customers often have complex requirements that necessitate a high level of institutional knowledge and assistance from sales teams.	Consumers can handle complexity themselves and require little to no sales support.
	High demand for reliability (to outweigh costs of downtime).	Consumers place less emphasis on reliability and accept potential malfunctions.
	Integration with legacy software in supply chains is required.	Due to homogeneity of consumers, support can often be automated.
Organizational Sophistication	Businesses follow specialized procurement procedures that are more selective.	Chances for widespread popularity and spontaneous buying influenced by word-of-mouth or social media.
	Marginal onboarding costs for an additional customer are rather high.	Marginal onboarding costs for an additional consumer are rather low.
	Ability to add value for the customer often necessitates industry expertise.	
	Industry knowledge is scattered and often not easily transferable between markets.	
Competition	In general, there is a smaller base of potential platform participants.	Overall, a high number of consumers exist as platform participants.
	Customers might encounter strong competition directly from other customers.	Consumers are not in direct competition with each other.
Data Governance	Customers have strong privacy concerns and know their data's value.	Consumers are less secretive with their data and are willing to use it as a form of "payment".
	Customers have a low incentive for information sharing with other participants.	Consumers show fewer concerns regarding data storage and security.
Dynamics	Weaker network effects raise the importance to offer standalone value.	Platforms require less market share to ignite network effects.
	Platforms can shift from offering standalone value creation to leveraging indirect network effects only after some time.	

2.3.2 Emerging Knowledge on Digital B2B Platform Ecosystems

Academic literature on B2B platforms has expanded in recent years, reflecting the increasing significance of the concept in shaping the digital business landscape (Madanaguli et al., 2023; Shree et al., 2021). Due to its novelty and the fact that firms often develop B2B platforms on top of existing (linear value chain) business models, early

work in this field has often focused on the organizational transformations of firms towards B2B platforms (Benbya et al., 2020; Beverungen et al., 2021; Jääskeläinen et al., 2021; Ritala & Jovanovic, 2024). For instance, Jovanovic et al. (2022) investigated how industrial manufacturers evolved their platform business by passing through different phases, from product platform to supply chain platform and, ultimately, to a platform ecosystem. In similar fashion, Sandberg et al. (2020) studied the evolution of ABB's platform for automating production processes, which was triggered by waves of increasing digitization and their effects on organizational outcomes. However, while these transitions document successful cases, many firms struggle with or fail to transform their business model and successfully build and scale B2B platforms (Falk & Riemensperger, 2019; Pidun et al., 2021).

Given the potential that digitalization has provided in manufacturing processes through new ways of digital servitization enabled by data generation and analyses (Kiel et al., 2017; Paiola & Gebauer, 2020), B2B platforms further began to emerge primarily in industrial markets. As a result, scholars have investigated digital industrial platforms as one key archetype of B2B platforms (Jovanovic et al., 2022; Madanaguli et al., 2023; Pauli et al., 2021; Veile et al., 2022). Insights of these studies have painted a clearer picture of how value co-creation, delivery, and capture and their interconnectedness differ in industrial platform settings (Madanaguli et al., 2023; Veile et al., 2022). For instance, to enable value co-creation processes with customers (Beverungen et al., 2021; Hein, Weking, et al., 2019), platform owners must foster a culture of trust to not be perceived as opportunistic (Dalenogare et al., 2023). This requires new governance mechanisms to build valuable transaction designs one by one, which makes this process more strenuous than in the B2C context (Sjödin et al., 2022; Tian et al., 2021).

Studying B2B platform emergence, recent literature also provides some initial insights. Marzi et al. (2023), for example, analyzed characteristics fostering or inhibiting the adoption of B2B platforms in small and medium-sized enterprises and large manufacturing firms. On the one hand, they find different intentions for platform adoption in both firm types, which helps B2B platform owners adjust their value proposition for each target market. On the other hand, they also uncover a group of perceived barriers and an absence of important benefits that impact the adoption of B2B platforms.

In similar fashion, Loukis et al. (2011), Hamad et al. (2018), and Wallbach et al. (2019)

investigated barriers to the diffusion of B2B marketplaces. They find that in B2B markets, many technological and organizational obstacles are difficult to overcome even for large enterprises, which points to a set of overall complex challenges that firms might not be able to solve alone. In this sense, Pushpananthan and Elmquist (2022) study how firms can leverage alliances that trigger the emergence of innovation ecosystems to cope with discontinuous technological change in a B2B industry. They find that such setups can have a dual impact on platform development, as they allow to distinctly develop new technology by combining various resources and knowledge and foster the development of complementary products as part of an emerging innovation ecosystem. This is in line with broader co-evolution perspectives of platform development, such as in the studies of Tian et al. (2021) and Jovanovic et al. (2022). They explain that B2B platform development is a co-creation process of many participating actors that the platform's lead actor steers. This is best enabled through joint capabilities and co-creation practices (Tian et al., 2021).

In the context of B2B platform orchestration, emergent literature also provides some insights. The literature here focuses on different aspects such as managing value creation and capture, coordinating ecosystem participants, or measuring the performance of the marketplace (Blaschke et al., 2018; Grewal et al., 2010; Hein, Weking, et al., 2019; Thitimajshima et al., 2018; Tian et al., 2021). To enable partners to self-integrate their resources for value creation, B2B platform operators must, for example, look for dynamic ways that lead toward standardized practices (Hein, Weking, et al., 2019). Only so can operators achieve scalability based on positive network externalities (McIntyre & Srinivasan, 2017). Further, to capture value from interactions enabled by the platform, operators may need to focus on a set of new mechanisms beyond typical commission earnings (Madanaguli et al., 2023; Schreieck et al., 2017). Schreieck et al. (2017), for instance, identify and describe three such mechanisms for value capture on B2B platforms that further the theoretical understanding in this regard. In another stream, researchers developed contextualized knowledge on the governance of B2B platform ecosystems (Grewal et al., 2010; Sen et al., 2023; Tian et al., 2021). While, for instance, Tian et al. (2021) develop orchestration capabilities that ensure successful co-evolution of the B2B platform and its partners, Grewal et al. (2010) investigate specific governance mechanisms to administer a B2B market. Taking an evolution perspective, Jovanovic et al. (2022) present how platform governance develops within a B2B platform along its expansion.

Yet, given expanding knowledge on the intricacies of digital B2B platform ecosystem emergence and orchestration, many B2B platforms still struggle to succeed (Stackpole, 2023). This points to important yet unsolved challenges in this context. I will take this as a starting point for the remainder of this dissertation, which will focus on closing a set of remaining research gaps.

3 Derivation of Research Gaps

Addressing the overall research objective of this dissertation, I focus on three distinct yet thematically intertwined research goals (RG) in the context of B2B platform emergence and orchestration. First, I aim to better understand the socio-technical factors that determine the adoption of digital B2B platforms. Second, I aim to describe how digital B2B platforms can be successfully developed and enter new markets. And third, I aim to provide guidance in orchestrating digital B2B platform ecosystems. These three research goals follow a sequential order, as the focus shifts from initial considerations pre-development to enable adoption to the actual development and market entry and, finally, the orchestration of established digital B2B platform ecosystems.

Figure 1 summarizes and visualizes the three research goals and the corresponding essays of this dissertation. In the following sections, I will introduce the research goals in more detail and derive specific research questions that I will answer.

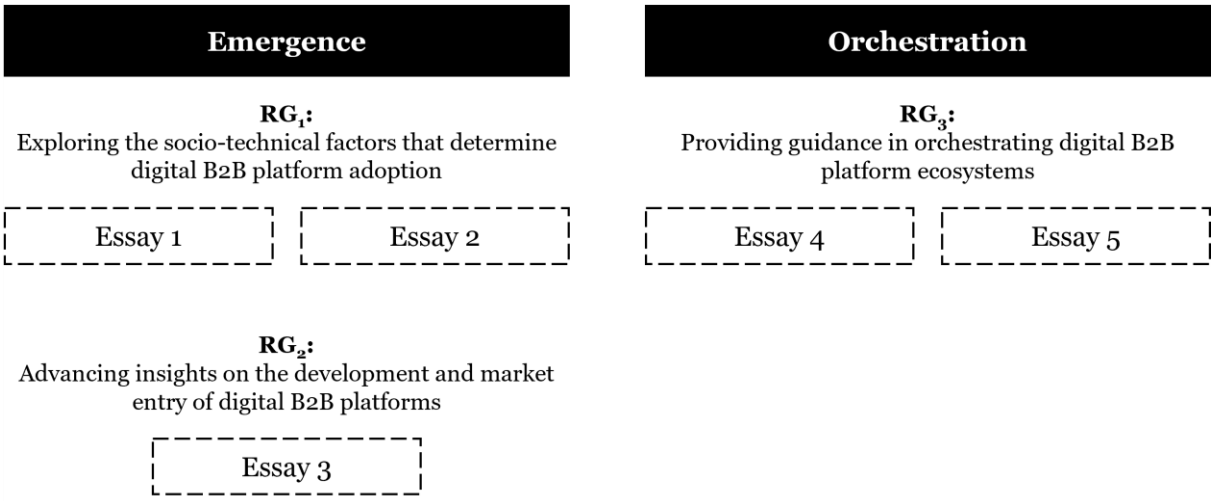

Figure 1. Overview of Research Goals on the Emergence and Orchestration of Digital B2B Platform Ecosystems

3.1 Exploring the Socio-Technical Factors of B2B Platform Adoption

Within the IS domain, technology adoption has been studied extensively with regard to why and how certain information systems are adopted or rejected (e.g., Salahshour Rad et al. (2018), Shree et al. (2021)). Adoption is the often complicated process of accepting or first using a technology or product (Legris et al., 2003). When viewed from an IS perspective, digital B2B platform ecosystems are socio-technical artifacts embedded in higher-level social and technical structures (Hein et al., 2020; K. Kapoor et al., 2021), which impact their adoption in the market. Comprehending the key drivers and inhibitors of their adoption is imperative to further their expansion. The first research goal, therefore, aims to shed light on the intricate factors that underpin the decision-making process of businesses when engaging with B2B platforms. As these factors are often context specific, I focus on the context of the industrial Internet of Things (IIoT) as an up-and-coming and general-purpose technology[16] domain in which digital B2B platforms have emerged early and which will likely be adopted in different industries such as healthcare (Ozalp et al., 2022), automotive (Svahn et al., 2017) or industrial equipment (Pauli et al., 2021) in the years to come. By pursuing this research goal, I aim to provide an analytical understanding of important socio-technical factors that platform architects must be aware of to ensure successful adoption. Thus, my first research goal is:

RG_1: Exploring the socio-technical factors that determine adoption of digital B2B platforms

The integration of information and communication technologies into industrial assets – known as the IIoT – enables companies to accrue a new host of data and process it with regard to untapped value propositions (Khan et al., 2020; Sisinni et al., 2018). To achieve these improvements, industrial firms often leverage digital platforms, referred to as IIoT platforms, to provide middleware solutions to integrate industrial assets into digital networks and extend them with externally provided analytical skills in the form of applications (Gawer & Cusumano, 2014; Pauli et al., 2021). However, given the potential of IIoT platforms to increase a firm's productivity, flexibility, or efficiency, companies are still reticent about adopting IIoT platforms, as underlined by the immature

[16] Digital technologies can be classified as general-purpose-technologies (GPTs) because they can be combined with a multitude of other technologies (Björkdahl, 2020). For insights on GPTs see Bresnahan and Trajtenberg (1995).

state of the market. This spotlights critical obstacles that potential users face when determining whether to adopt an IIoT platform. Aiming to address them, research has identified different challenges so far: on the one hand, research in the IIoT domain has focused on various technical challenges that may inhibit the efforts of IIoT platforms to perform in the envisioned way. These challenges can be classified into three types, namely heterogeneity and interoperability, data integration and management, and data and cyber-security (e.g., Khan et al. (2020), Sisinni et al. (2018), Serror et al. (2021)). While the insights generated in this domain are valuable, they leave out other relevant challenges encountered within (traditional and asset-heavy) organizations and their wider environment. In this regard, research has, on the other hand, only recently begun to understand these perspectives. This includes, for example, the management of expectations and benefits realized through IIoT platforms or the required investment of financial, personal, and time resources in adopting IIoT platform solutions (Madanaguli et al., 2023). In summary, current knowledge misses out on capturing the whole picture that explains why IIoT are experiencing such low adoption, and especially comes up short in two ways: first, many challenges known so far have been identified in either isolated or different contexts, missing out on their interdependencies and implications, which especially IIoT platforms have to cope with. And second, the majority of challenges known so far are technical-oriented, leaving us in the dark about organizational and environmental factors that might influence IIoT platform adoption. Therefore, I ask:

What challenges impede industrial organizations' adoption of IIoT platforms?
(Essay 1)

Overcoming fundamental technical, organizational, and environmental challenges to platform adoption represents only one facet of the journey, though. Another essential dimension lies in the ability of IIoT platforms to effectively communicate their value proposition to potential users and complementors, thereby triggering adoption. The landscape of IIoT platforms encompasses a diverse array of use cases characterized by significant disparities in their underlying technological infrastructure and architectural configurations, as documented in prior research (e.g., Mineraud et al. (2016), Guth et al. (2018)). This heterogeneity can be attributed, in part, to the technical complexity within B2B settings and the absence of established standards in the IIoT domain, contributing to the fragmented development of these platforms (Khan et al.,

2020). This, however, poses issues for potential users and complementors alike: for companies as users seeking to navigate the IIoT platform market in selecting an IIoT platform that fits their existing IT infrastructure, it creates difficulties in understanding. This is further complicated because no comprehensive framework exists to organize and guide such decisions. For companies as complementors, the fragmentation creates issues in systematically understanding the internal architecture of IIoT platforms when they are tailoring their code (i.e., application) with platform core resources to develop new offerings that are competitively faring (Tiwana, 2018). Lastly, it presents challenges for researchers and strategists aiming to grasp the intricate interplay between IIoT platform architecture and business models—a critical interplay within the realm of digital business that fosters competitive advantage (Cennamo, 2021; Zhu & Iansiti, 2012). While prior research has made substantial headway in investigating various aspects of IIoT platforms, such as their business models (Hodapp et al., 2019), analytics frameworks (Moura et al., 2018), or design criteria (Werner & Petrik, 2019), there remains a conspicuous gap in the field: a unified framework for categorizing the fundamental architectural design options of IIoT platforms. Such a framework is essential not only to facilitate transparent evaluation and comparison of existing IIoT platforms but also to provide platform architects with the required knowledge about their underlying architectural setup to better communicate a value proposition to potential users and complementors. Addressing this research gap, I ask:

How can IIoT platforms be classified by their architectural features? (Essay 2)

3.2 Advancing Insights on the Development and Market Entry of B2B Platforms

Understanding the factors inhibiting and enhancing the adoption of digital B2B platforms, platform architects can use this knowledge for successful development and market entry of new platform ventures. Research provides a powerful vocabulary for the explanations of a wide range of platform strategies, such as how they grow (J. Huang et al., 2017), compete (Foerderer et al., 2018), and innovate (Hukal et al., 2020). However, these insights commonly only relate to platforms serving markets with end-consumers as at least one of their participant groups. The implicit assumption that such findings generalize and apply to B2B environments as well risks, as I have laid out earlier, to ignore the particularities and downplay the complexities faced in such

environments. Therefore, my second research goal focuses on the dynamics in B2B markets and how platform architects can overcome them. Addressing this research goal, I aim to provide an explanatory understanding of how digital B2B platforms can successfully emerge. Thus, my second research goal reads:

RG_2: Advancing insights on the development and market entry of digital B2B platforms

Entering new markets is challenging for any digital platform since the logic of cross-side network effects holds that potential users are reluctant to join unless a large installed base of actors exists on the corresponding side. To address this challenge, research suggests different strategies on how to enroll and retain different types of participants (Carroni et al., 2023; Dou & Wu, 2021), grow content (Rietveld et al., 2019), or create new services (Boudreau, 2012). In B2B markets, however, digital platforms face an altogether varied set of challenges that must be addressed. Most importantly, competitive aspects of businesses as users lead to a fear of potential lock-in and dependency on a biased network regulator (Chakravarty et al., 2014; B. Yoo et al., 2007). This challenge is even exacerbated when digital platforms are – as most often portrayed in the literature – owned by single, powerful players (Kaplan & Swahney, 2000). Consortium or decentralized ownership may alleviate the bias, as it allows a larger group to participate in decision making, thus, fostering trust (Floetgen et al., 2023; Hsieh & Vergne, 2023). It is, however, unclear how decisions of ownership and governance interact with strategic moves to launch a digital B2B platform and enter a new market. Considering this context, I ask:

How can digital B2B platforms successfully enter markets? (Essay 3)

3.3 Providing guidance in Orchestrating B2B Platform Ecosystems

As digital platforms provide a technological foundation to facilitate the interaction of different sides, the resulting organizational form (often referred to as a meta-organization (Kretschmer et al., 2022)) requires thoughtful orchestration for successful evolution. Traditionally, the management and IS literature have relied on the concept of "governance" as the responsible, effective, and entrepreneurial management of an organization (van Grembergen et al., 2004). In the context of digital platforms, platform governance builds on more IT-centric models adapted from organizational IT governance (Schreieck et al., 2023; Tiwana et al., 2013). However, the platform governance

concept per se, as well as specific mechanisms relevant to B2B markets, are continuously changing and require persistent adaptation. Therefore, my third research goal focuses on improving platform governance and addressing emerging challenges and opportunities in the B2B landscape. Engaging with this research goal, I aim to provide a prescriptive understanding of how digital B2B platform ecosystems can be orchestrated for successful evolution. Thus, my third research goal is:

RG_3: Providing guidance in orchestrating B2B platform ecosystems

Digital platforms have been studied in multiple settings to understand their unique governance opportunities. These studies have resulted in different streams with narrow perspectives and competing definitions, causing what can be described as a Babylonian confusion. Broadly, these streams can be broken down into four types: one that focuses on platform governance as the practice of formal decision making (e.g., Tiwana et al. (2010)), one that focuses on the practice of influencing and controlling behavior (e.g., Song et al. (2018)), one that focuses on governance as the practice of solving tensions within the platform ecosystem (e.g., Wareham et al. (2014)), and one that focuses on the practice of organizing value co-creation and capture (e.g., Chen, Tong, et al. (2022)). Aiming for successful evolution, (B2B) platform orchestrators currently must connect different puzzle pieces on platform governance for a holistic understanding of the right guidelines. In addition, from a theoretical standpoint, researchers may benefit from the development of a cumulative body of knowledge that enables the discovery of white spots and conceptual limits in our current understanding. Thus, my research objective here is:

To ease the Babylonian confusion, I aim to merge the different views of platform governance and develop an integrative platform orchestration concept and an actionable platform orchestration framework for leveraging the benefits of digital platforms and their surrounding ecosystems (Essay 4)

Standardization can be critical in enabling platform ecosystems to emerge in the B2B domain (e.g., Wiegmann et al. (2017), Costabile et al. (2022), Tessmann and Elbert (2022)). Platform architects and orchestrators may use it as a form of direct control to enable "order by reducing the variety of processes" (Wright et al., 2012, p. 652) and thus allow recombinability of products and services (Y. Yoo et al., 2010) which are typically highly heterogeneous in the B2B domain. However, our understanding of how standardization (e.g., of processes, interfaces, or designs) impacts the innovation

capabilities of a digital platform is inconclusive and poor. While the impact of this interplay has received scant attention in the platform literature, it draws from a rich body of work in the broader technology and innovation management literature (Hawkins & Blind, 2017; Wiegmann et al., 2017). This literature stream, however, offers conflicting views on their interplay. While the traditional view holds that standardization and innovation are opposing forces, as standards represent organizational control and regulation impeding change to the state of the art (Blind, 2016; Swann, 2010), an emerging body of literature also recognizes the benefits of standardization for innovation (Miric et al., 2023; Wright et al., 2012; Zoo et al., 2017). In summary, whether standardization stifles or enables innovation is largely unknown in the platform literature, leaving much to be learned about how platform orchestrators must manage standardization in the process of evolving digital B2B platform ecosystems. Thus, I ask:

What are the effects of standardization on digital platform innovation? (Essay 5)

4 Research Design

This dissertation comprises five essays that address the three research goals described in the preceding chapter. The essays are presented after this introduction, reflecting the cumulative approach taken in this dissertation. Table 3 provides an overview of the essays and their current publication status.

Table 3. Overview of the Five Essays included in this Dissertation

	Title	Publication Outlet	Status[17]
RG_1: Exploring the Socio-Technical Factors that Determine B2B Platform Adoption			
1	Challenges of Organizations' Adoption of IIoT Platforms – Results of a Delphi Study	International Journal of Innovation and Technology Management *(VHB-JQ: C, AJG: 1)*[18]	Published
2	IIoT Platforms' Architectural Features: A Taxonomy and Five Prevalent Archetypes	Electronic Markets *(VHB-JQ: B, AJG: 2)* Previous version presented at: International Conference on Wirtschaftsinformatik 2021	Published
RG_2: Advancing Insights on the Development and Market Entry of B2B Platforms			
3	Consortium Governance and Market Entry of Digital B2B Platforms: The Case of ADAMOS	Information Systems Journal *(VHB-JQ: A, AJG: 4)* Previous version presented at: Symplatform 4	In Revision
RG_3: Providing Guidance in Orchestrating B2B Platform Ecosystems			
4	Platform Ecosystem Orchestration: A Conceptual Framework and Research Agenda	Electronic Markets *(VHB-JQ: B, AJG: 2)*	In Revision
5	The Varying Effects of Standardization on Digital Platform Innovation: Evidence from OpenStreetMap	Innovation: Organization & Management *(VHB-JQ: -, AJG: 2)* Previous version presented at: Academy of Management Annual Meeting 2023 Accepted for presentation at: DRUID 2023	Under Review

[17] As of December 2023

[18] VHB-JQ: Jourqual 3 ranking of the German Association for Business Research; AJG: 2021 Academic Journal Guide (AJG) of the Chartered Association of Business Schools.

The essays have either been published in renowned information systems and management journals and conferences or are currently in revision or under review. All essays are collaborative efforts with my co-authors. Consequently, I use the plural *we* when referring to the essays and our joint work.

4.1 Pragmatist Research Paradigm

From a philosophical perspective, research follows different ontological and epistemological assumptions about the nature of reality and our understanding of it, and methodologies defining the most appropriate research design to acquire knowledge, resulting in different research paradigms (Guba & Lincoln, 1994; Mingers, 2001). In science, the consensual set of beliefs and practices that guide a field is typically referred to as a "paradigm" (Morgan, 2007). The analytical approach followed in this thesis is shaped by a pragmatist research paradigm (Creswell, 2013; Davidson, 1984; Wicks & Freeman, 1998). Pragmatism has been developed as an alternative to abstract and rationalistic sciences (Goldkuhl, 2011, 2012). It emphasizes practicality, action, and the application of knowledge to real-world problems and situations. To a certain degree, it shares objections made by a hermeneutic and constructivist post-positivism (Goldkuhl, 2011; Wicks & Freeman, 1998). However, it determines the goodness of subjective interpretations not by evaluating if they make sense; pragmatism requires interpretations to make sense practically.

Studying phenomena of digital B2B platform ecosystems, a pragmatist stance recognizes that no single methodological approach can meticulously capture and explain them. Answers to questions of what there is to know about the emergence and orchestration of B2B platforms simply require a pluralistic methodology (Mingers, 2001; Morgan, 2007). Pragmatism is thus inclusive of different methodologies and bridges qualitative and quantitative epistemologies (Morgan, 2007; Yin, 2015). In fact, pragmatists often advocate for mixed methods research to combine the strengths of the different approaches (Mingers, 2001; Venkatesh et al., 2013).

Contributions of pragmatist research can thus be achieved through various approaches and be of different kinds as long as they yield utility for those interested in the phenomenon (Wicks & Freeman, 1998). That is, contributions must not necessarily be of design or action type (Gregor, 2006) but can also include actionable knowledge in the

form of recommendations, strategies, or detailed empirical analysis (Wicks & Freeman, 1998).

In line with the pluralistic approach to methods, pragmatism allows the combination of diverse data sources to derive such useful contributions. The prevailing mode of reasoning with the data is characterized by abductive inference, which encompasses moving back and forth between inductive and deductive approaches: first inductively converting observations into theories and followed by assessing their effectiveness in predicting the feasibility of future actions (Morgan, 2007). Through this combination, whether explicitly articulated or tacitly implied, and by iteratively engaging with the data, theoretical constructs, and analytical procedures, pragmatism seeks knowledge discovery. Abduction, within this philosophical context, serves as an epistemic framework committed to the derivation of insights that are obtained directly from empirical data, as opposed to being preconceived by a-priori theoretical concepts. This methodological orientation underscores the primacy of anchoring insights in the empirical realities and context pertinent to the phenomenon and thereby engenders a fundamentally practical, contextually responsive, and adaptive research approach conducive to situational necessities (Lorino, 2018; Maxcy, 2003; Mueller & Urbach, 2017; Venkatesh et al., 2013).

4.2 Research Methods

The studies within this dissertation adhere to a pragmatist approach in the subsequent manner. First, the studies incorporate diverse and novel data sources and combine data of varying types. Second, to maximize the utility of the data, various analytical techniques are interwoven within each of the studies. Third, a distinctive abductive approach to theoretical development characterizes each study. Hence, the investigation unfolds through a continuous iterative process, integrating both inductive and deductive modes of reasoning to derive emerging insights from the phenomena under scrutiny.

Table 4 summarizes the research designs and specific methods, the data used, and the context in which they were collected. In the following, I explain the rationale behind the choices and briefly outline the execution of the different methods. I refer to each essay's method section for a detailed description.

Table 4. Overview of Research Designs, Context and Data

	Methodology	Methods	Context and Data
1	Survey research	Delphi study; survey instrument; qualitative content analysis	- Context: Industrial IoT platform market - Data: 22 IIoT experts from academia and practice surveyed over five rounds
2	Multi-method research	Taxonomy development; literature review; interviews; cluster analysis	- Context: Industrial IoT platform market - Data: 7 semi-structured interviews with IIoT experts; information on 78 IIoT platforms
3	Case study research	Interpretive case analysis; expert interviews	- Context: ADAMOS IIoT platform - Primary data: 30 semi-structured interviews with ADAMOS stakeholders - Secondary data: Internal and external documents; public interviews
4	Literature review	Systematic literature review; analytical inductive theory building	- Conceptual Paper - Data: 162 scientific papers with insights on platform governance
5	Quasi experiment	Expert interviews; qualitative content analysis; interrupted time series analysis	- Context: OpenStreetMap platform - Data: 5 background interviews with OSM developers; 25,000 community forum mails; 1,52 million tagged geodata

In Essay 1, we followed a survey research approach and conducted a Delphi study with 22 IIoT platform experts from academia and practice. Delphi studies strive for consensus on a specific topic with a panel of experts over multiple rounds utilizing questionnaires interspersed with feedback (Okoli & Pawlowski, 2004; Paré et al., 2013). As this essay's research question relates to novel and fundamental challenges in the IIoT platform market, this exploratory method is appropriate since it enables us to draw on the collective knowledge gained by experts with first-hand experience of the subject. We chose a ranking-type Delphi study design (Paré et al., 2013; Schmidt, 1997) that involved five rounds: in the first round, we asked the experts to name and briefly describe current challenges experienced by companies in the adoption of IIoT platforms. Consolidating the responses, we first iteratively coded all input to identify overlapping and multiply stated challenges (Krippendorff, 2013; Schmidt, 1997), before merging them into 36 specific and separate challenges. To validate these results, we performed a second brainstorming round and asked the panel to comment on the challenges and their proposed definitions as well as note any absences among the list. In round three, we sought to narrow-down the list and identify the most relevant challenges, which led to

the final list of 29 items. Last, in two rating rounds, the experts were asked to rate these challenges based on a provided scale according to their comparative relevance. In the second rating round, the panel was further divided into subpanels of practitioners and academics to reveal potential variations in their views of the challenges' significance. Throughout all rounds, we tracked the convergence of the results via qualitative and quantitative feedback from the participants, ensuring the internal and external validity of the panel's consensus.

In Essay 2, we followed a multi-method research approach that combines qualitative-empirical and quantitative methods in two subsequent steps. This approach is regularly chosen in IS research to systematize novel research phenomena and identify patterns. As a first step, we developed a taxonomy of architectural features of industrial IoT platforms. Based on the iterative method outlined by Nickerson et al. (2013), we alternately conducted two conceptual-to-empirical and two empirical-to-conceptual iterations to identify and conceptualize relevant dimensions and characteristics of IIoT platforms' architectural features. Thus, our taxonomy reflects extant knowledge of the literature asl well as novel insights from empiricism and experts in the field. Besides further developing the dimensions and characteristics, insights from experts derived through interview also led us to systematically evaluate the taxonomy and its internal and external validity. Having successfully met the pre-defined ending conditions, we set out elucidate typical architectural setups of IIoT platforms. To this end and as second step, we collected data on 78 IIoT platforms that provided real-world cases for cluster analysis. We used a publicly available database of IIoT platforms to systematically select instances of different sizes, popularity levels, and with different value propositions. We then applied our taxonomy and extracted information on the cases from publicly available sources (e.g., technical documentation, whitepaper, website description). To identify typical combinations of architectural features, we applied agglomerative hierarchical clustering using the Ward algorithm and the Manhattan distance function (Hair et al., 2010). As agglomerative hierarchical clustering shows solutions for all possible numbers of clusters, we triangulated between different statistical measures (e.g., C-index), visual graph interpretation (e.g., average silhouette width), and interpretability based on our own understanding to choose the optimal number of clusters.

In Essay 3, we followed a qualitative approach to single case study research of the

industrial IoT platform ADAMOS (Eisenhardt, 1989; Yin, 2018). Case study research is appropriate for exploratory research objectives and allows researchers to capture and deeply understand organizational phenomena – such as the development and market entry specifics of digital B2B platforms, as outlined in the essay's research questions (Walsham, 1995, 2006; Yin, 2018). Using this understanding, one can build theory in the form of theoretical constructs, measures, or testable propositions (Eisenhardt & Graebner, 2007). This process occurs via recursive cycling among different case data, emerging theoretical concepts, and extant literature (ibid.). We collected and combined both primary and secondary data, aiming to understand how ADAMOS successfully developed and scaled its platform by applying a consortium-owned governance approach. To gather primary data, we systematically selected informants covering different stakeholder groups and conducted a total of 30 semi-structured interviews that included participants' interpretations of the phenomenon (Walsham, 1995). As such interview data are often not free of bias, we also collected various secondary data in the form of internal documents (e.g., presentations or published whitepapers of ADAMOS), public documents (e.g., press releases or market reports about ADAMOS), and podcast interviews about ADAMOS (Klein & Myers, 1999; Schultze & Avital, 2011). Analyzing the data, we adopted an iterative method using grounded theory methodology. This involved progressively coding the data with greater levels of abstraction and examining our findings in the context of theoretical preconceptions (Corbin & Strauss, 2008; Wiesche et al., 2017). Through our work with the data and consistently triangulating emergent insights from primary data with secondary data, we came to understand the interaction between ADAMOS' governance decisions and the effects on its successful market entry. Synthesizing our findings, we relied on theoretical preconceptions of platform development tactics to develop a four-step framework that relates key decisions and activities identified in the case to each tactic.

In Essay 4, we conducted an organizing review to synthesize and order the currently scattered understanding of platform governance in the literature (Leidner, 2018). Organizing reviews aim to make a large and diversified body of literature understandable and suit phenomena that cannot be fully captured by an existing theory (ibid.). We followed the guidelines of Webster and Watson (2002) and Wolfswinkel et al. (2013) and organized the review process in four steps. First, we defined a review plan that included a structure for data collection and coding as well as criteria for inclusion and exclusion of literature. Second, we searched and extracted publications from

Clarivate's citation indexing service (Web of Science) using a pre-defined search query. We limited the results to a specific timeframe and publication outlet quality. Next, in multiple screening iterations and complementing the literature selection with additional backward searches, we reduced the initial search result of 635 articles to a final sample of 162 articles. Last, we analyzed these articles and extracted 173 unique platform orchestration elements using our uniform data collection and coding structure. Adopting thematic analysis (Braun & Clarke, 2006, 2019), we systematically aggregated the elements to higher-level themes, which served as the baseline for an iterative framework-building process. To this end, we came up with an emerging framework that is comprehensively exhaustive and mutually exclusive when explaining the integrative platform orchestration concept.

In Essay 5, we follow the tradition of exploratory, natural experiments about policy changes in platform settings (e.g., Claussen et al. (2013), S. Ye et al. (2014), M. Wessel et al. (2017)) to deepen our understanding of the effects of standardization on innovation on digital platforms. Utilizing the geodata platform OpenStreetMap (OSM) as our research object, we tracked and compared data before and after a discrete standardization effort and quantitatively analyzed them in an approach that is referred to as interrupted time series analysis (ITSA) (Gottmann, 1981; Linden, 2015; Sadish et al., 2003). Doing so, we constructed a unique dataset of OSM geodata objects that covers the timeframe of ±50 weeks around the standardization effort (i.e., intervention) and developed several variables to measure the innovation on the platform level in terms of quantity and quality of new content. Analyzing the data, we adopt interrupted time series analysis as a quasi-experimental research design to investigate the impact of the intervention (Linden et al. 2018). We used an ordinary least squares regression model with standard errors adjusted for serial correlation and included a vector of control variables to account for alternative explanations (Linden, 2015; Turner et al., 2021). As a single group ITSA has no comparable control group, we extrapolated the pre-intervention trend into the post-intervention period to serve as a counterfactual and, thus, evaluated the intervention's effect.

5 Summary of Results

The following section will briefly summarize the results of the five essays. The synthesis of these essays provides an in-depth and domain-specific understanding to successfully navigate the emergence and orchestration of digital B2B platform ecosystems.

5.1 Essay 1: Challenges of Organizations' Adoption of IIoT Platforms – Results of a Delphi Study

Building on the Delphi research approach, this study takes a holistic perspective on technological, organizational, and environmental challenges that impede organizations' adoption of IIoT platforms. In total, my co-authors and I identify 29 challenges (13 from the technological perspective, eight from the organizational, and eight from the environmental) that surpass the scope of existing related literature. Technological challenges present the largest cluster and cover topics regarding the industrial IoT as a technology paradigm and its functioning. In line with our goal of identifying issues beyond the technical focus of the current computer science and engineering IIoT literature, we further identified 16 non-technical challenges. The organizational perspective subsumes eight challenges that focus either on the platform operator's business model or potential platform users' managerial issues. Last, the environmental perspective covers eight challenges that deal with market regulation and the platform's orchestration.

In addition to the identification and structuring of these issues, we also reveal their comparative relevance. By applying a simple majority rule on the challenges ratings, we derive *insufficient system interoperability*, *insufficient semantic interoperability*, and *unclear business privacy* as the three most relevant obstacles. Last, we also uncover differences in how important academics and practitioners perceive the different challenges. The findings show that academics tend to focus on technical issues, while practitioners tend to focus more on organizational and environmental issues. Since the literature has not yet considered the commonalities and differences of these groups, we open and describe new perspectives for diverse research strands in the IIoT platform domain. In summary, our empirical results indicate that IIoT platform adoption is determined not only by characteristics of the underlying technologies but also by factors relating to the readiness of platform operators and platform users and the

external environment. Therefore, it summarizes and updates the most critical challenges and highlights important avenues for future research to overcome them.

5.2 Essay 2: IIoT Platform' Architectural Features: A Taxonomy and Five Prevalent Archetypes

Concluding the taxonomy development process and quantitative analysis of 78 real-world cases, this study offers two key findings: First, we present a taxonomy of architectural features of IIoT platforms. The taxonomy consists of 13 dimensions encompassing 38 characteristics. Aiming for comprehensiveness and real-world fidelity, we rely on established layers (i.e., infrastructure, network, middleware, and application layer (Y. Yoo et al., 2010)) to structure the dimensions. In this sense, the taxonomies' dimensions cover the technical resources on which the platform operates and the smart things that are connected to it (infrastructure layer), the frameworks and technologies that enable connectivity and interoperability of different devices and applications (network layer), the way that data is integrated with applications on the platform to enable its processing (middleware layer), and the way new functionalities in the form of applications can be integrated with the platform (application layer). Second, based on the taxonomy and data collected from 78 real-world cases, we derive five archetypes of IIoT platform setups (Allrounder, Device Controller, Data Hub, Service Enabler, and Connector). These archetypes each demonstrate distinct characteristics within our taxonomy and are, therefore, able to offer different business values to potential users.

From a theoretical standpoint, our results provide descriptive knowledge in this young research field by structuring and explaining what architectural features constitute prevalent manifestations of IIoT platforms. Further, our derivation of five archetypical setups demonstrates the interplay between an IIoT platforms' architectural setup and its business purpose. From a practical standpoint, our results inform practitioners in selecting the right IIoT platforms in the market of increasingly heterogenous solutions.

5.3 Essay 3: Consortium Governance and Market Entry of Digital B2B Platforms: The Case of ADAMOS

In this essay, we investigate the successful market entry of the ADAMOS IIoT platform. Building on its case analysis my co-authors and I derive three main results: first, we present a detailed reconstruction of the platform and its key components through a

case narrative. We organize this narrative to represent the temporal sequence of key decisions and activities that shaped the ADAMOS platform and its market entry. Second, leveraging the insights from the in-depth case description, we derive a framework that presents success factors enabled by ADAMOS' consortium governance approach. We frame the success factors by decomposing the ADAMOS market entry into a sequence of four distinct steps: first, defining an organizational setup that suits the requirements of the envisaged market (spinning out); second, designing a valuable platform core that is the basis for add-ons later (coring); third, populating the supply side with initial applications (seeding); and fourth, opening the platform for a broader customer base and create demand for offered products and services (opening). Last, we reflect on the lessons that can be learned from ADAMOS' story, especially with regard to the consortium-governance approach, B2B market entry, and B2B platform development.

In summary, this essay contributes valuable practical insights for the successful market entry of digital B2B platforms. The framework and its four steps offer detailed guidance on how a consortium approach to platform governance can yield strategic benefits to overcome challenges to platform development and B2B market entry. Further, this study contributes to ongoing academic conversations, especially in the emerging body of literature on B2B platforms. Besides detailing how market entry strategies differ in their implementation between B2C and B2B markets, this study adds nuance to a better understanding of consortium governance as an approach to platform ownership and operation in general.

5.4 Essay 4: Platform Ecosystem Orchestration: A Conceptual Framework and Research Agenda

This study aims to alleviate current confusion around platform governance by presenting platform orchestration as a concept that reconnects different views. Doing so, this study first offers an overview of the four different streams that literature on platform governance has splintered into. To mend this fragmentation, my co-authors and I develop an integrative platform orchestration concept. Subsequently, to make this concept actionable for theory and practice, we also develop a framework that classifies platform orchestration into two main components: orchestration instruments, which describe the structural decisions and coopetitive (i.e., cooperative and competitive)

activities platform operators can take to steer the platform ecosystem and orchestration capabilities, which describe the organizational competencies required to do so. Last, we use the framework and the results from our literature analysis to identify open issues and fruitful directions for future research. Therefore, we describe subject-matter gaps that emerged as we synthesized the framework as well as conceptual issues we identified in the platform governance literature.

Our results contribute to nomological clarity through the conceptualization of platform orchestration, offer an actionable framework to classify and work with this novel concept and sketch blank spots for further valuable investigations. In addition, practice may benefit from our framework and the concrete examples its description entails when developing and operationalizing a concrete platform orchestration strategy.

5.5 Essay 5: The Varying Effects of Standardization on Digital Platform Innovation: Evidence from OpenStreetMap

This study investigates the effect of increasing standardization on digital platform innovation. In line with other researchers in the field (e.g., Hukal et al. (2020)), we divide and measure innovation in terms of quantity and quality on the platform. We find that the intervention had positive and negative effects on platform innovations on OpenStreetMap, which we summarize in four different outcomes (control, ease of use, simplification, and spillover effect). We differentiate and describe these effects in terms of their impact on innovation quantity and quality and whether the innovation was initially in focus of the standardization or not. Our findings align with the rich body of work on standardization and innovation in technology and innovation management and its application as a form of control on digital platforms (e.g., Acemoglu et al. (2012), Wright et al. (2012), Miric et al. (2023)). While – on the surface - standardization appears to be an ordinary formal control mechanism used to deselect undesirable outcomes, it supports – on a deeper level - the diffusion of innovation on the platform and enables entirely new innovation to emerge.

From a theoretical standpoint, our results highlight the value of viewing and studying control on digital platforms through the lens of standardization. Further, our results are interesting for academia and practice alike. While scholars interested in questions of whether and how innovation can be controlled on digital platforms benefit from the novel perspective and insights (e.g., Rietveld et al. (2019), Cennamo and Santaló

(2019)), practitioners that seek guidance in orchestrating a digital platform benefit from better understanding of its ambivalent effects.

6 Discussion and Conclusion

The results of the five essays contribute to theory and practice by investigating and answering research questions important to a better understanding of the emergence and orchestration of digital B2B platform ecosystems. In the following, I will summarize this dissertation's main findings before highlighting specific contributions to research and implications for practice resulting from them. Last, I will reflect on limitations and outline avenues for future research.

6.1 Summary

Digitalization has given rise to a new emblematic organizational form, that of the digital platform ecosystem (Gawer, 2022). Given that a growing number of (emergent and incumbent) firms are embracing business models aligning with the concept of a digital platform ecosystem, this dissertation investigates the dynamics that underlie the emergence and orchestration of such organizational forms in the B2B context. I build on prior work on digital platforms, business and innovation ecosystems, and different perspectives on their evolution, which developed in large parts in the B2C context, to further our theoretical understanding of B2B platforms and develop strategic guidance for platform architects and orchestrators. Doing so, I structured this dissertation along three research goals. Seeking to explore the socio-technical factors determining B2B platform adoption (RG_1), Essay 1 identifies and summarizes technical, organizational, and environmental challenges impeding B2B platform adoption. In addition, Essay 2 investigates architectural features as the determining factor in offering distinct value propositions. In sum, these insights allow platform architects to address current challenges and better define platform value propositions to facilitate successful adoption. As the B2B environment poses different obstacles to platform development and market entry, RG_2 (through Essay 3 respectively) advances the portfolio of strategies platform architects can use to overcome such challenges and successfully guide a B2B platform to market entry. Lastly, Essays 4 and 5 provide guidance in orchestrating digital B2B platform ecosystems for sustainable and long-term evolution (RG_3).

In sum, I provide theoretical and practical insights into the emergence and orchestration of digital B2B platforms. Following a multi-method research approach, the five essays allow for the generation of descriptive, analytical, and prescriptive knowledge that benefits not only the overall body of knowledge on digital platforms and ecosystems but, in particular, the emergent literature stream on digital B2B platforms.

6.2 Contributions to Research

The findings of this dissertation contribute valuable insights for current academic conversations on digital platforms in general and B2B platforms in specific.

6.2.1 Specific Contribution to the Understanding of the Emergence and Orchestration of Digital B2B Platform Ecosystems

In line with the first and second research goals, I add to a better understanding of the emergence of digital B2B platform ecosystems. Scholars have repeatedly emphasized its importance and called for more research to study how platform ecosystems can emerge (e.g., Reuver et al. (2018), Daymond et al. (2023)). Hence, achieving my first research goal, I contribute knowledge that enhances the adoption of B2B platforms. Essay 1 consolidates and updates the most significant challenges inhibiting the wide-scale success of IIoT platforms as one specific B2B platform type. By uncovering and ranking these obstacles, scholars can take the right steps to foster the diffusion of B2B platforms. In addition, the study highlights several disparities when comparing the perceived relevance of the obstacles between academics and practitioners, offering an insightful comparison to the existing literature. Taking a contrary approach to foster adoption, Essay 2 develops knowledge to better assess or guide the value proposition of B2B platforms. While the literature has commonly focused on a business model perspective (e.g., Hodapp et al. (2019)), the study shifts the focus toward the underlying platform architecture that constitutes “an information technology artifact’s virtually irreversible DNA” (Tiwana, 2018, p. 829). This new perspective enriches our comprehensive understanding of how and what value B2B platforms can offer by emphasizing their structural foundations as the determining factor. Achieving my second research goal, I contribute processual insights on how successful platform development and market entry by B2B platforms can be achieved. Doing so, Essay 3 adds context to how common platform launch strategies such as coring, seeding, or opening (e.g., P. Huang

et al. (2018), Karhu et al. (2020)), which hitherto are primarily informed by studying B2C platforms, differ in their implementation between B2C and B2B markets. Further, as the results of this study elucidate several strategic advantages of a consortium-based approach to platform ownership and governance over other approaches (i.e., single or open ownership), they engage directly with those who surmise that platforms that are sponsored by a consortium achieve higher levels of trust and are, therefore more likely to succeed in B2B markets (Anderson et al., 2022).

In line with my third research goal, I contribute to a better understanding of the orchestration of digital B2B platform ecosystems. Overcoming the current splintering of perspectives on platform governance, Essay 4 contributes to literature interested in orchestrating platform ecosystems by developing a comprehensive framework that conceptualizes platform ecosystem orchestration and provides it with the necessary contour. The framework delineates the different components involved in orchestrating platform ecosystems, thus compiling a holistic perspective that merges formerly separately examined governance decisions, activities, and capabilities. In addition, Essay 5 contributes to our theoretical understanding of the dynamics and varying effects of standardization on digital platform innovation. Thus, it sheds light on the hitherto underrepresented form of standardization as a viable form of platform control. This contribution, therefore, engages with long-standing discussions on the tensions of "resourcing vs. securing" (Ghazawneh & Henfridsson, 2013), "generativity vs. control" (Eaton et al., 2015), or "autonomy vs. control" (Wareham et al., 2014) and introduces a new option to ease this tension.

6.2.2 General Contributions to Literature on Digital Platform Ecosystems

Besides these specific contributions, the essays contribute more abstract knowledge to management and information systems literature on digital platform ecosystems. First, many of the organizational and environmental challenges that Essay 1 identifies are important beyond the B2B context. For instance, born-closed organizations seeking to participate in a platform economy to serve their end-consumers will face similar challenges. Hence, these insights also inform general research on the digital transformation of firms to leverage the benefits of platform-based business models. Second, as Essay 2 finds several distinct archetypes of IIoT platforms, the classification shows that

the previously seen homogenous group of this B2B platform instance is, in fact, very heterogeneous, which bears important implications for their emergence and orchestration. For instance, development activities in many of the IIoT platform archetypes happen within the platform users' organization for their own use. Schreieck, Wiesche, and Krcmar (2019) refer to this as "customers as developers" and show how platform orchestration must change to, among others, account for indirect network effects not being applicable anymore. Understanding such differences thereby helps to clarify the distinction between B2C and B2B platforms. Third, as Essay 3 uncovers several strategic advantages of consortium ownership and governance for B2B platform development and market entry, two more general contributions flow from its analysis: on the one hand, the study shows that successful market entry by B2B platforms begins pre-development with the decision on a proper organizational setup that fits the target market. The story of ADAMOS highlights the decisions and activities pre-development of the platform (i.e., the consortium formation and spinning out of a separate legal platform entity) and, thus, informs ongoing discussions of early-stage platform development (e.g., Shi et al. (2021), Hsieh and Vergne (2023)). On the other hand, the study adds nuance to a better understanding of consortium governance as an approach to platform ownership and orchestration. While existing literature alleges shared ownership as a viable platform structure (Costabile et al., 2022; Eisenmann, 2008; Pushpananthan & Elmquist, 2022), it comes up short in elucidating its peculiarities when compared to single or open ownership models. The study, therefore, contributes to closing this gap. Fourth, Essay 4 develops a future research agenda that contributes to the general platform literature by laying out how to advance our understanding of platform orchestration. Doing so, it addresses some important shortcomings of current platform literature as a whole. Last, Essay 5 contributes to the literature that discusses control on digital platforms by introducing standardization as a viable form, which has thus far not been considered. This opens new research opportunities for digital platforms in general that may benefit from controlling innovation through increased standardization.

6.3 Implications for Practice

Beyond contributing to ongoing academic conversations, this dissertation also holds valuable practical implications by providing design or management-oriented knowledge through specific artifacts or frameworks. Platform architects and

orchestrators can use them to better design, develop, and orchestrate B2B platform ecosystems.

More specifically, Essay 2 provides platform architects with a taxonomy to better understand different manifestations of architectural features of IIoT platforms. Utilizing this, platform architects can better align value propositions along its dimensions and characteristics to offer tailored and high-quality services to platform customers. Essay 3 describes key decisions, activities, and tactics of the successful market entry of the ADAMOS platform that provide utility for architects of other B2B platforms. We summarize these insights in a four-step framework that may guide platform architects' future works. Next, although rather theoretical, the platform orchestration framework of Essay 4 explains different facets that platform orchestrators must keep in mind for successfully steering a B2B platform ecosystem. In addition, while deriving the framework, this study also provides ample examples of how orchestration practices look like in other platform contexts for others to lean on. Last, Essay 5 offers insights for platform orchestrators on the varying effects of increasing standardization on a platform's innovation capacity. The resulting matrix adds to a better understanding of the interdependence of standardization and innovation, which is of particular importance in the B2B domain going forward (e.g., Hein, Weking, et al. (2019)).

6.4 Limitations and Future Research

The essays underlying this dissertation are subject to different limitations. In the following, I will not reiterate the individual limitations of each study but rather present two aggregate and important boundary conditions of this work in general. Further, I will propose ways to overcome these limitations in future research and give an outlook on fruitful future research avenues on digital B2B platform ecosystems beyond.

The first limitation concerns the possibility of varying outcomes based on applying different data sets with the studies' research methods, which impacts the generalizability of the results. This dissertation's first three studies focus on the industrial Internet of Things as a specific context where B2B platforms operate. While the IIoT refers to a set of general-purpose technologies whose adoption is likely in different B2B industries and the IIoT platforms studied follow a business model similar to many other modular technology platforms to foster complementary innovation in the form of software solutions, it is important to recognize that the choice of the IIoT and unique

characteristics of it have possibly influenced the results. For instance, studying the adoption challenges of B2B platforms in the automotive, healthcare, or agriculture industries may yield slightly different results. Hence, my results may not be entirely representative of the broader landscape of B2B platforms, and researchers and practitioners should exercise caution when extrapolating the findings to other contexts of interest. Future research may, thus, focus on such other contexts to validate, adjust, or expand these insights and enhance their external validity. A second limitation that requires mention pertains to the insights guiding the orchestration of B2B platform ecosystems. B2B platforms as modular technology systems are still an emergent phenomenon, which limits the development and evaluation of guiding principles for successful orchestration. Therefore, I aim to derive insights through a conceptualization based on extant literature (see Essay 4) and analysis of orchestration mechanisms that will most likely apply to platforms in both the B2C and B2B contexts (see Essay 5). However, a detailed evaluation of these insights in a real-world B2B setting is missing. Future research may address this limitation through either natural experiment-like approaches or empirical investigations once they are feasible.

Beyond overcoming these limitations, the field of digital B2B platform ecosystems offers numerous avenues for future research on their emergence and orchestration. In the following, I will elaborate on three promising directions. First, many companies are thinking about adopting platform principles and opening their business model to allow outside actors to participate in the process of value creation and/or delivery. However, not every current manufacturing firm is destined for a platform-based business model. Take, for instance, companies that operate in an industry that does not experience high fragmentation on supply or demand sides or that specialize in creating technological solutions tailored to individual customers. These settings will probably not benefit from strong network effects or complementary innovation of third parties. Instead, these companies may be better off focusing on building a sound position as a complementor in someone else's platform ecosystem (Jacobides, 2022; Ritala & Jovanovic, 2024). How to differ between these types and guide organizations in deciding what strategic position works best for them in a platform economy is unknown yet of strategic importance and high value for firms. Thus, future research may focus on defining the boundary conditions to determine who is suited or not to become a B2B platform.

Second, given the differences between B2C and B2B platform ecosystems, the continuing transfer of known concepts, strategies, and mechanisms from the B2C to the B2B context holds vast potential for further advancing our understanding of B2B platform emergence and orchestration. While Essay 3 sheds light on how such knowledge transfer may look like for market entry strategies, numerous other concepts (e.g., ordinary and dynamic capabilities (e.g., Tan et al. (2015)) or cooperative and competitive activities (e.g., Hannah and Eisenhardt (2018), Ozcan and Santos (2015)) warrant exploration. Examining how these concepts must be tailored or reconfigured to suit the distinct characteristics and dynamics of B2B interactions will be pivotal in guiding platform architects and orchestrators. In this vein, an important aspect that sets B2B ecosystems apart is the imperative of sustaining long-term relationships with customers. Therefore, the prevalent *fail fast, learn fast* mantra that has driven innovation in the B2C may not be as applicable in B2B settings. Failures in the B2B sphere can disrupt and destroy long-term relationships and customer value, necessitating a more cautious and strategic approach to innovation and adaptation. Exploring how B2B platforms navigate the tension between innovation and relationship preservation offers a promising avenue for future research on their emergence. Another intriguing area of exploration lies in balancing value capture between platform owners and complementors in the B2B context (e.g., Madanaguli et al. (2023)). While in the B2C, platform owners regularly leverage the work of individuals and less organized complementors (i.e., individuals) for massive platform growth, they do so by enforcing a variety of unfair practices and complementors are often not able to lobby for better conditions (J. Evans, 2022; Williams, 2020)[19]. One may expect contrasting dynamics in the B2B, where complementors are potentially established and organized businesses[20] that may not allow exploitation to happen the same way or without a fight[21]. Hence, investigating the strategies and mechanisms used by complementors when facing competitive or exploitative pressures from platform owners, or vice versa, can be highly insightful.

[19] Apple, for example, is accused of unfair business practices by forcing complementors to use Apple's own payment system or by taking up to 30% commission. In other fashion, Amazon is accused of self-preferencing its own products and services at the expense of complementors. Jacobides et al. (2024) relate to the platform's abuse of power to extract excessive value from its complementors as "distributional failure".

[20] Due to operational complexity and organizational sophistication of platform customers that complementors must be able to deal with.

[21] See, for example, the lawsuits of Spotify or Epic Games versus Apple or Google, which could be argued to have emerged largely due to their sophisticated organizational formation.

Last, significant opportunities exist to improve our knowledge about platform orchestration to foster B2B platform ecosystem's prosperity. While platform orchestration is a complex balancing act because of the multiple sides the platform should create value for, different objectives and incentives of the orchestrator and the sides also make platform or ecosystem failures likely (Jacobides et al., 2024). Hence, the worm is in the seed, and future research may investigate how functional or distributional failures can be addressed or overcome through adjusted orchestration. For instance, there is growing interest – primarily in the B2C context – in how the abusive use of the power of the platform owner must be limited through new tools of antitrust laws (e.g., Jenny (2021), Jacobides and Lianos (2021)). However, for B2B platforms to thrive in the near future, another way to address such failures may be more important: self-regulation (e.g., Cusumano et al. (2021)). To attract and retain complementors and users, B2B platforms may need to develop novel self-policing practices that lead to a fair and efficient platform ecosystem. Defining what such practices can look like, how effective they are, and what potential side effects they have will further our domain-specific understanding of successful B2B platform orchestration.

Digital B2B platform ecosystems provide new ways to think about the organization of economic activity and how such structures can be superior to a vertically integrated firm. However, the emergence and orchestration of B2B platforms come with unique challenges, and how to overcome them is thus far not sufficiently understood. With this dissertation, I hope to contribute to this discourse to foster the expansion of B2B platforms in the years to come.

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Appendices

Appendix A: Declarations of Co-Authorship and Individual Contributions

In the following, I describe the co-authors' contributions to the essays.

Essay 1: Challenges of Organizations' Adoption of IIoT Platforms – Results of a Delphi Study

This research paper was co-authored by Laurin Arnold, Philip Karnebogen, and Nils Urbach. The authors contributed to the research (in line with CRediT[22]) as follows:

Laurin Arnold (lead author):

Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Validation, Writing – Original Draft, Writing – Review & Editing, Visualization, Project Administration

Philip Karnebogen (subordinate co-author):

Conceptualization, Validation, Writing – Review & Editing

Nils Urbach (subordinate co-author):

Conceptualization, Writing – Review & Editing, Supervision

[22] I refer to the CRediT author statement as introduced by Brand et al. (2015) Learned Publishing 28(2)

Essay 2: IIoT Platform' Architectural Features: A Taxonomy and Five Prevalent Archetypes

This research paper was co-authored by Laurin Arnold, Philip Karnebogen, and Nils Urbach. The authors contributed to the research (in line with CRediT) as follows:

Laurin Arnold (equal co- author):

Conceptualization, Methodology, Investigation, Data Curation, Validation, Visualization, Writing – Original Draft, Writing – Review & Editing, Project Administration

Jan Jöhnk (equal co- author):

Conceptualization, Methodology, Formal Analysis, Writing – Review & Editing, Supervision

Florian Vogt (equal co- author):

Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft, Writing – Review & Editing

Nils Urbach (subordinate co- author):

Conceptualization, Writing – Review & Editing, Supervision

Essay 3: Consortium Governance and Market Entry of Digital B2B Platforms: The Case of ADAMOS

This research paper was co-authored by Laurin Arnold, Philipp Hukal, and Marco Link. The authors contributed to the research (in line with CRediT) as follows:

Laurin Arnold (lead author):

Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Project Administration

Philipp Hukal (subordinate co-author):

Conceptualization, Methodology, Validation, Writing – Original Draft, Writing – Review & Editing

Marco Link (subordinate co-author):

Resources, Validation, Writing – Review & Editing

Essay 4: Platform Ecosystem Orchestration: A Conceptual Framework and Research Agenda

This research paper was co-authored by Laurin Arnold, Alexander Rieger, and Nils Urbach. The authors contributed to the research (in line with CRediT) as follows:

Laurin Arnold (lead author):

Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Validation, Writing – Original Draft, Writing – Review & Editing, Project Administration

Alexander Rieger (subordinate co-author):

Conceptualization, Methodology, Validation, Writing – Original Draft, Writing – Review & Editing

Nils Urbach (subordinate co-author):

Conceptualization, Writing – Review & Editing, Supervision

Essay 5: The Varying Effects of Standardization on Digital Platform Innovation: Evidence from OpenStreetMap

This research paper was co-authored by Laurin Arnold and Philipp Hukal. The authors contributed to the research (in line with CRediT) as follows:

Laurin Arnold (equal co-author):

Conceptualization, Methodology, Data Curation, Formal Analysis, Validation, Resources, Writing – Original Draft, Writing – Review & Editing, Project Administration

Philipp Hukal (equal co-author):

Conceptualization, Methodology, Investigation, Formal Analysis, Validation, Writing – Original Draft, Writing – Review & Editing

Appendix B: Other Publications and Working Papers

While working on this dissertation, I also co-authored the following research papers and publications. This work is not part of this dissertation.

Table B.1. Overview of Other Research Papers and Publications

Reference	Ranking	Status
Jöhnk, J., Albrecht, T., Arnold, L., Guggenberger, T., Lämmermann, L., Schweizer, A., & Urbach, N. (2021). The Rise of the Machines: Conceptualizing the Machine Economy. *Proceedings of the 25th Pacific Asia Conference on Information Systems*. https://eref.uni-bayreuth.de/66555/	VHB: C AJG: -	Published
Arnold, L., Graf-Drasch, V., Wolf, L., Gimpel, H., & Keller, R. (2024). Citizens' preferences on smart energy technologies and services for smart districts. *Cities*.	VHB: - AJG: 2	Accepted for Publication
Arnold, L., Grüneke, T., & Röglinger, M. (2023). Managing Cognitive Load in Massive Open Online Courses: Evidence from Coursera.		Working Paper
Arnold, L., Ollig, P., Rieger, A., Roth, T., Stohr, A., & Fridgen, G. (2023). Decentralized Platforms as Catalyst for an End-to-End Digitalization of the Public Sector: The Case of Germany´s FLORA Platform.		Working Paper
Arnold, L., Brennecke, M., Camus, P., Fridgen, G., Guggenberger, T., Radszuwill, S., Rieger, A., Schweizer, A., & Urbach, N. (2019). *Blockchain and Initial Coin Offerings: Blockchain's Implications for Crowdfunding*. In: Business transformation through blockchain. Vol. 1, pp. 233–272. Palgrave Macmillan. https://eref.uni-bayreuth.de/46499/	n/a	Published
Arnold, L., Buck, C., Guggenberger, T., & Häckel, B. (2023). *Digitale Plattform-Ökosysteme – Von linearer zu vernetzter Wertschöpfung von Unternehmen*. Whitepaper of the Fraunhofer Institute for Applied Information Technology FIT. https://eref.uni-bayreuth.de/id/eprint/76516/	n/a	Published
Urbach, N., Albrecht, T., Guggenberger, T., Jöhnk, J., Arnold, L., Gebert, J., Jelito, D., Lämmermann, L., & Schweizer, A. (2020). *The Advance of the Machines: Vision und Implikationen einer Machine Economy*. Whitepaper of the Fraunhofer Institute for Applied Information Technology FIT. https://eref.uni-bayreuth.de/58029/	n/a	Published
Amend, J., Arnold, L., Feulner, S., Fridgen, G., Köhler, F., Ollig, P., Rieger, A., & Roth, T. (2022). Opportunities and challenges of using blockchain technology in public administration – Insights from the FLORA project of Germany´s Federal Office for Migration and Refugees. Whitepaper of the German Federal Office for Migration and Refugees.	n/a	Published

Amend, J., Arnold, L., Fabri, L., Feulner, S., Fridgen, G., Harzer, L.-L., Karnebogen, P., Köhler, F., Ollig, P., Rieger, A., & Schmidbauer-Wolf, G.-M. (2022). Federal Blockchain Infrastructure Asylum (FLORA) – Piloting and evaluation of the FLORA support system in the context of the AnkER facility Dresden. Whitepaper of the German Federal Office for Migration and Refugees.	n/a	Published

Essay 1
Challenges of Organizations' Adoption of Industrial IoT Platforms – Results of a Delphi Study

Authors

Laurin Arnold, Philip Karnebogen, Nils Urbach

Abstract

Companies are still reticent about adopting IIoT platforms, and research has not yet explained the underlying challenges that impede such adoption. Uncovering these obstacles can open avenues for research and practice to realize the intended potential. We take a holistic perspective on technological, organizational, and environmental challenges that impede organizations' adoption of IIoT platforms, which we identify in a Delphi study with 22 international experts from academia and practice. Besides identifying 29 challenges, our research reveals the comparative relevance of individual challenges, uncovering differences in perceptions between academics and practitioners. The study contributes to the diffusion of IIoT platforms in research and practice.

Keywords: *Industrial IoT, IIoT Platform, Adoption, Challenge, Delphi Study*

This essay has been published as:

Arnold, L., Karnebogen, P., & Urbach, N. (2023). Challenges of Organizations' Adoption of Industrial IoT Platforms – Results of a Delphi Study. *International Journal of Innovation and Technology Management*, *20*(6), 2350041, https://doi.org/10.1142/S0219877023500414.

Essay 2
IIoT Platforms' Architectural Features – A Taxonomy and Five Prevalent Archetypes

Authors

Laurin Arnold, Jan Jöhnk, Florian Vogt, Nils Urbach

Abstract

In the industrial Internet of Things (IIoT), digital platforms have recently received significant attention. Although IIoT platforms revolve around similar business objectives, they address various use cases and, thus, differ considerably in their architectural setup. While research has already investigated IIoT platforms from a business or design perspective, little is known about their underlying technology stack and its implications. To unveil different IIoT platform configurations and better understand their architectural design, we systematically develop and validate a taxonomy of IIoT platforms' architectural features based on related literature, real-world cases, and expert interviews. On this foundation, we identify and discuss five IIoT platform archetypes (Allrounder, Device Controller, Data Hub, Service Enabler, Connector). Our findings contribute to the descriptive knowledge in this ambiguous research field while also elucidating the interplay of IIoT platforms' architectural setup and their purpose. From a managerial viewpoint, our results may guide practitioners in comparing and selecting a suitable IIoT platform.

Keywords: *Industrial IoT, IIoT Platform, Architecture, Archetypes, Taxonomy*

This essay has been published as:

Arnold, L., Jöhnk, J., Vogt, F., & Urbach, N. (2022). IIoT platforms' architectural features – A taxonomy and five prevalent archetypes. *Electronic Markets*, *32*, 927-944, https://doi.org/10.1007/s12525-021-00520-0.

A previous version of this essay has also been published as:

Arnold, L., Jöhnk, J., Vogt, F., & Urbach, N. (2021). A Taxonomy of Industrial IoT Platforms' Architectural Features. *Proceedings of the International Conference on Wirtschaftsinformatik 2021*, Essen, Germany.

Essay 3
Consortium Governance and Market Entry of Digital B2B Platforms: The Case of ADAMOS[1]

Authors

Laurin Arnold, Philipp Hukal, Marco Link

Extended Abstract

Digital platforms that connect businesses with other businesses are increasingly important for economic activity worldwide, as they provide innovative transaction designs across entire industries and solve important coordination problems in markets characterized by enormous transaction volumes (Ritala & Jovanovic, 2024). However, market entry by business-to-business (B2B) platforms is challenging. B2B platforms operate in industries where platform adoption requires solving complex coordination problems, often at a high level of technical sophistication, to address a limited yet heterogenous market of potential customers entrenched in intricate networks of business relationships (Anderson et al., 2022). While the applied and academic literature on digital platforms provides a robust and powerful vocabulary to articulate platform launch and entry strategies, most of its principles relate to business-to-consumer (B2C) platforms. This is problematic as ignoring the particularities and complexities of B2B relationships in incumbent industries downplays the challenges operators of B2B platforms face. In this paper, we conducted a single case study (Eisenhardt & Graebner, 2007; Yin, 2018) to understand how the Industrial Internet of Things platform, ADAMOS, addressed these challenges and successfully entered the German mechanical engineering market.

We find that ADAMOS successfully launched its platform by following a consortium approach to platform governance that separated platform ownership from platform operation. By setting up a joint venture among industry incumbents, ADAMOS was able to address the complexity and challenges of market entry in a B2B segment and overcome the colloquial chicken-and-egg problem of platform launch (e.g., Parker et al., 2017; Rysman, 2009). We present these findings through a framework using

[1] At the time of publication of this dissertation, this essay is under review at a scientific journal. Thus, I provide an extended abstract that covers the essay's content.

vocabulary from the literature on platform strategy and articulate four steps platform architects can apply to their industries: first, spin out the platform as an independent entity to separate platform ownership from operation and form an organizational setup that suits the target market. Second, design valuable core functionalities for users of that target market. Third, populate the supply side with initial value units to enable first interactions. Fourth, open the platform and invite other industry participants to join the platform to create larger demand for the offered products and services. In addition, we describe three valuable lessons learned from the ADAMOS case. The findings of this case study thus contribute actionable insights for practitioners and researchers interested in successful market entry of B2B platforms.

Keywords: *B2B Platforms, Market Entry, Platform Governance, Consortium Ownership, Case Study*

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Essay 4
Platform Ecosystem Orchestration: A Conceptual Framework and Research Agenda[2]

Authors

Laurin Arnold, Alexander Rieger, Nils Urbach

Extended Abstract

In today's hyper-competitive markets, companies often need more than just their own resources and capabilities to succeed. They increasingly must become "inverted firms" (Parker et al., 2017) that innovate by orchestrating the outputs of external complementors (Cennamo, 2021; Hein et al., 2020). In contrast to the traditional pipeline model, platform ecosystems require platform operators to focus less on their own innovations and market offerings and rather facilitate independent complementors to successfully innovate and market their offerings (Gawer, 2014; Jacobides et al., 2018; Kretschmer et al., 2022). Platform governance has been studied in multiple settings to understand the unique opportunities that this organizational setup enables and requires. Doing so, however, the literature on platform governance has splintered into four different streams of understanding over the last years, which makes it hard to grasp how to successfully navigate platform ecosystems.

In this study, we aim to ease the resulting Babylonian confusion by presenting an integrative platform orchestration concept and an actionable platform orchestration framework for leveraging the benefits of digital platforms and their surrounding ecosystems as an interorganizational value architecture and business model. Our concept and framework draw on the emerging metaphor of platform orchestration, which supports a more inclusive and broader understanding of platform governance. Our framework builds on an organizing review (Leidner, 2018) of 162 studies published between 2000 to 2022 in the strategic management, information systems, economics, and marketing disciplines. We analyzed this literature using qualitative and quantitative techniques to iteratively develop the emerging framework until it was comprehensively exhaustive and mutually exclusive (Braun & Clarke, 2006, 2009; Webster & Watson,

[2] At the time of publication of this dissertation, this essay is under review at a scientific journal. Thus, I provide an extended abstract that covers the essay's content.

2002; Wolfswinkel et al., 2013). This analysis helped us distill and synthesize the various elements of platform governance into a conceptual framework that consists of two first-order categories (orchestration instruments and orchestration capabilities) and six second-order orchestration aspects (platform and ecosystem parameters, cooperative and competitive activities, and ordinary and dynamic capabilities). Building on the conceptual framework of platform orchestration and our literature analysis, we subsequently discuss blank spots and identify fruitful directions for future research on the orchestration of digital platform ecosystems.

Keywords: *Digital Platform, Platform Ecosystem, Platform Orchestration, Platform Governance, Research Agenda*

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Essay 5
The Varying Effects of Standardization on Digital Platform Innovation: Evidence from OpenStreetMap[3,4]

Authors

Laurin Arnold, Philipp Hukal

Extended Abstract

Lately, the platform literature exhibits increasing interest in controlling innovation on platforms. Much attention is paid to the challenge of attracting outside contributions in line with the strategic intentions of the platform operator (e.g., Boudreau (2010), Rietveld et al. (2019), Hukal et al. (2020)). A central idea echoed in this stream of research is that attracting and guiding innovation by outside contributors on platforms needs some control. However, effectively implementing this kind of control on platforms is not straightforward since it must balance "desirable and undesirable variation" (Wareham et al., 2014).

In this study, we investigate the effects of standardization as a means of direct control on digital platform innovation. While standardization can be promising to control activity in complex technical systems (Lindgren et al., 2021), the effects of standardization are difficult to predict for digital platforms: On platforms, the generation of content is a function of diverse actors engaging with each other, and thus platforms innovate thanks to many very different actors whose presence and activity are not always under the control of the platform operator (Eaton et al., 2015; Ens et al., 2023). Surprisingly, the rich body of work on standardization and technology innovation is largely ignored in work on digital platforms (Acemoglu et al., 2012; Wright et al., 2012). Thus, whether standardization stifles or enables innovation is largely unknown in the platform literature, leaving much to be learned about controlling the quality and quantity of innovative content on platforms through standardization.

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[3] At the time of publication of this dissertation, this essay is under review at a scientific journal. Thus, I provide an extended abstract that covers the essay's content.

[4] A previous version of this essay has been published as:
Arnold, L., & Hukal, P. (2023). The Varying Effects of Standardization on Digital Platform Innovation: Evidence from OpenStreetMap. *Academy of Management Annual Meeting Proceedings*, (1), https://doi.org/10.5465/AMPROC.2023.11216abstract.

Specifically, we study the standardization of parameters and procedures implemented through the web editing API on the popular geo-data platform, OpenStreetMap. We collected data on the number and detail of geospatial data objects across the 100 largest European cities, spanning 100 weeks (50 weeks before and after the standardization, respectively). Using a regression-based approach to interrupted time series analysis (Gottmann, 1981; Linden, 2015), we assess the quantity and quality of new content generated on the platform before and after the standardization.

We find that the intervention had positive and negative effects on platform innovations on OpenStreetMap, which we summarize in four different outcomes (control, ease of use, simplification, and spillover effect). We differentiate and describe these effects in terms of their impact on innovation quantity and quality and whether the innovation was initially in focus of the standardization or not. Framing these findings through the rich body of work on standardization and innovation in the technology management literature (e.g., Acemoglu et al. (2012), Hawkins & Blind (2017), Wright et al. (2012), Wen et al. (2022)), we engage a long-standing tension in research on digital platforms -- the balance between control and innovation on platforms. We discuss the prospect of standardization as one way to directly control the balance between desirable and undesirable variation necessary for platforms to innovate, as standardization restricts some activities while enabling others.

Keywords: *Digital Platform, Platform Innovation, Standardization, Control, Intervention*

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